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Electricity for Railway Work

MODERN STEAM GENERATING PLANT AT SECURITY, MD., SUPPLIES BULK OF OUTPUT FOR TRACTION PURPOSES; AUTOMATIC REGULATION OF STOKER AND BLOWER MOTORS RENDERS BOILERS CAPABLE OF MEETING SUDDEN DEMANDS

THE HAGERSTOWN & FREDERICK Railway Co., a consolidation of 10 former small electric railway, gas and electric lighting properties, operates about 90 miles of road, serving a population of approximately 60,000, and by means of an interurban railway, connects Hagerstown, the county seat of Washington County, Maryland, and Frederick, the county seat of Frederick County, also in Maryland. Its lines also extend from Frederick to Thurmont, where connection is made with the Western Maryland Railway Co. A line runs from Frederick to Braddock Heights on the crest of the Catoctin Mountain range, thence to Middleton and Myersville, where connection is made with the railway running into Hagerstown. From Hagerstown, a branch line runs to Williamsport, Maryland, and from a point midway between Hagerstown and Myersville a line runs to Boonsboro, Maryland. There is also an extension from Braddock Heights to Jefferson, Maryland, from which point a further extension is planned to Brunswick.

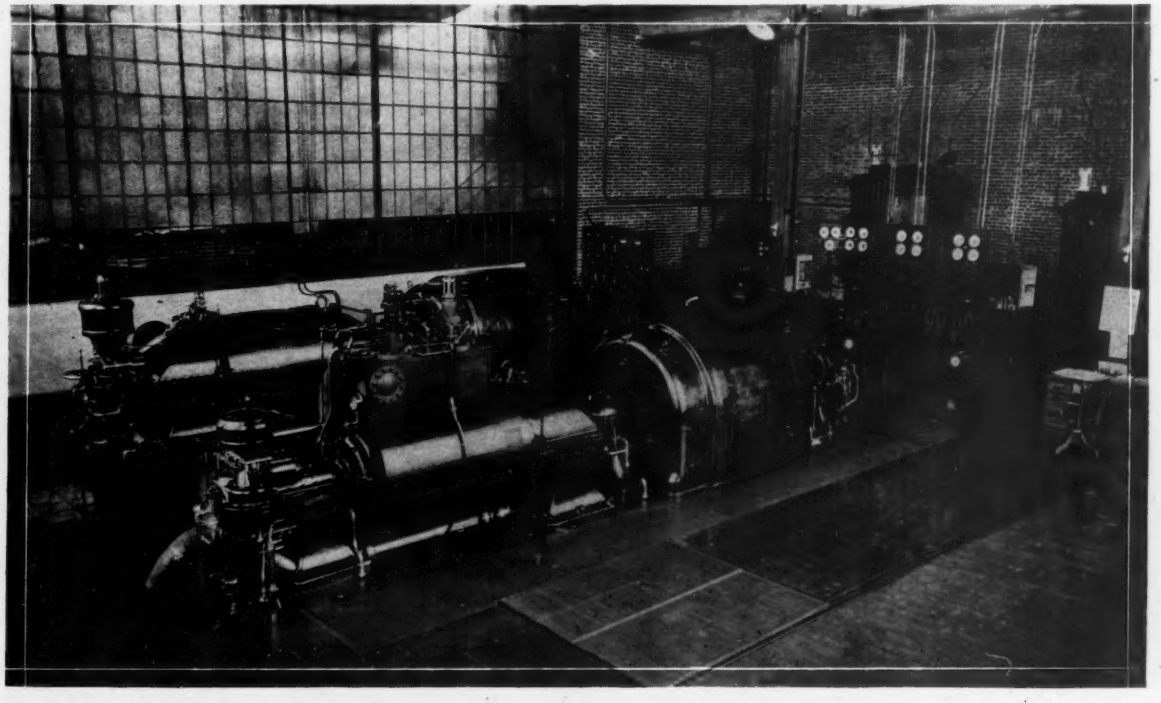


FIG. 7. GENERAL VIEW OF TURBINE ROOM

In addition to the regular passenger service, this company also handles freight trains, owning and operating a number of heavy electric locomotives for that work. Most of the hauling of freight is done at night at a time when the passenger service is extremely light, thereby tending to keep the power station operating more efficiently than if all the load were carried during the daytime and early evening and none at night.

Due to the fact that the high-tension transmission lines of this company pass through Hagerstown, Thurmont and Frederick, these places and many other smaller towns and villages near by are enabled to obtain current for electric light and power.

To prevent the possibility of any service interruption, the high tension transmission line which operates at a voltage of 33,000, is built in the form of a loop by being

FIG. 1. EXTERIOR VIEW OF SECURITY POWER PLANT

carried from the power station at Security to Thurmont, then to Frederick, to Hagerstown and thence back to Security. Should any part of the system become disabled, the various substations located along the line may still be kept in operation, receiving their energy from that part of the line still intact.

Current for the operation of this system is received from a steam generating station located at Security, a point on the main line of the Western Maryland Railway, a few miles out of Hagerstown.

The building, which is approximately 170 ft. long by 68 ft. wide, is of fireproof construction, concrete, brick and steel being the materials used. The stack is of the Alphonse-Custodius radial hollow tile type; it is 150 ft. high, 14 ft. in diameter at the base and has an ultimate capacity of approximately 3600 hp.

All foundations are of concrete sunk to bed rock.

Steam Generation

Water for steam making and condensing purposes may be obtained from either one or both of 2 nearby streams the characteristics of whose waters are entirely opposite of one another. It is found that one of these waters contains considerable scale-forming matter while the other may be said to be practically pure and when fed to the boilers has a tendency to remove any scale which may form from the use of the other water.

It has therefore become the practice here to use that water containing the scale-forming elements until a deposit of scale has been formed, when the other water is used which in a short time removes all the scale present, so that by the alternate use of these 2 waters, it is possible to keep the boilers in good operating condition.

Before being delivered to the boilers, the water is passed through a Cochrane feed water heater and purifier rated at 3000 hp. and containing 40 trays having a

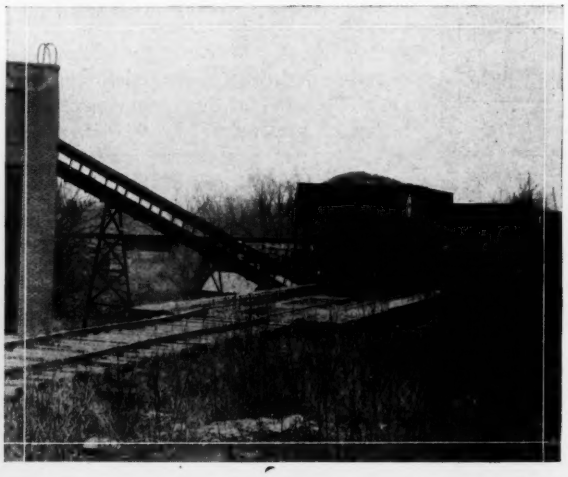


FIG. 2. INCLINED COAL CONVEYOR AT REAR OF BOILER ROOM

capacity of 106 cu. ft. Steam for heating the water is obtained from the exhausts of the station's auxiliary apparatus.

All water used is measured by a Worthington plunger type water meter.

Coal is brought in over a siding from the Western Maryland Railway and is crushed to pass through a ½-in. screen by a 50-ton Robbins coal crusher. Then by means of a belt conveyor it is carried to steel coal bunkers located directly above and in front of the boilers, from where it passes through chutes into the hoppers of Taylor stokers. Figure 3 illustrates the interior of the boiler room and shows the general construction of the hoppers, while Fig. 2 is an exterior view of the boiler room showing the inclined conveyor.

Steam is generated in 3 Stirling water-tube boilers rated at 700 hp. each and provided with B. & W. superheaters which superheat the steam 50 deg. F. at full load. A steam pressure of 175 lb. gage is ordinarily carried.

Operation of Boilers

On account of the extreme variations of load existing on an electric railway system it is necessary, if efficient and economical operation is to result, that the power plant equipment be capable of easily and readily meeting such extremes of load. Especially is this so of the boilers. To meet these demands an ingenious arrangement of stoker motor and blower motor control is installed.

Three blower motors, each connected to an 18,000 cu. ft. Sturtevant blower and each furnishing the necessary forced draft for one boiler are used. For the operation of the stokers, 2 motors are installed, one of which is in continuous use, while the other is held in reserve. These 5 motors are direct-current compound-wound machines with their series fields connected to the exciter bus bars, as shown in Fig. 4. The armatures and shunt fields of these motors receive their current from one of 2 50-kw. motor generator sets, the direct-current shunt field of which is controlled by a rheostat, the operation of which depends upon the working of a Mason damper regulator.

With an increase of load, the plunger of the damper regulator operates, by means of a link chair, sprocket wheel and counter weight, the shunt field rheostat of the generator connected to the armatures and shunt fields of the various motors, so that with an increase of load the resistance of the shunt field will be decreased, the armature voltage increased and as a consequence

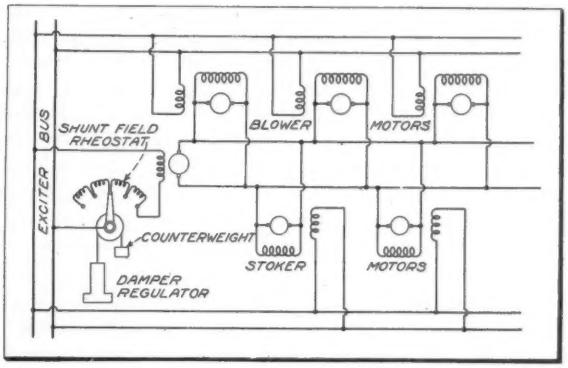


FIG. 4. WIRING DIAGRAM OF STOKER AND BLOWER MOTOR CONTROL

due to the combined action of this increase in voltage and that of the series field the blower and stoker motors are caused to speed up, and aid the boiler in meeting the demand for more steam.

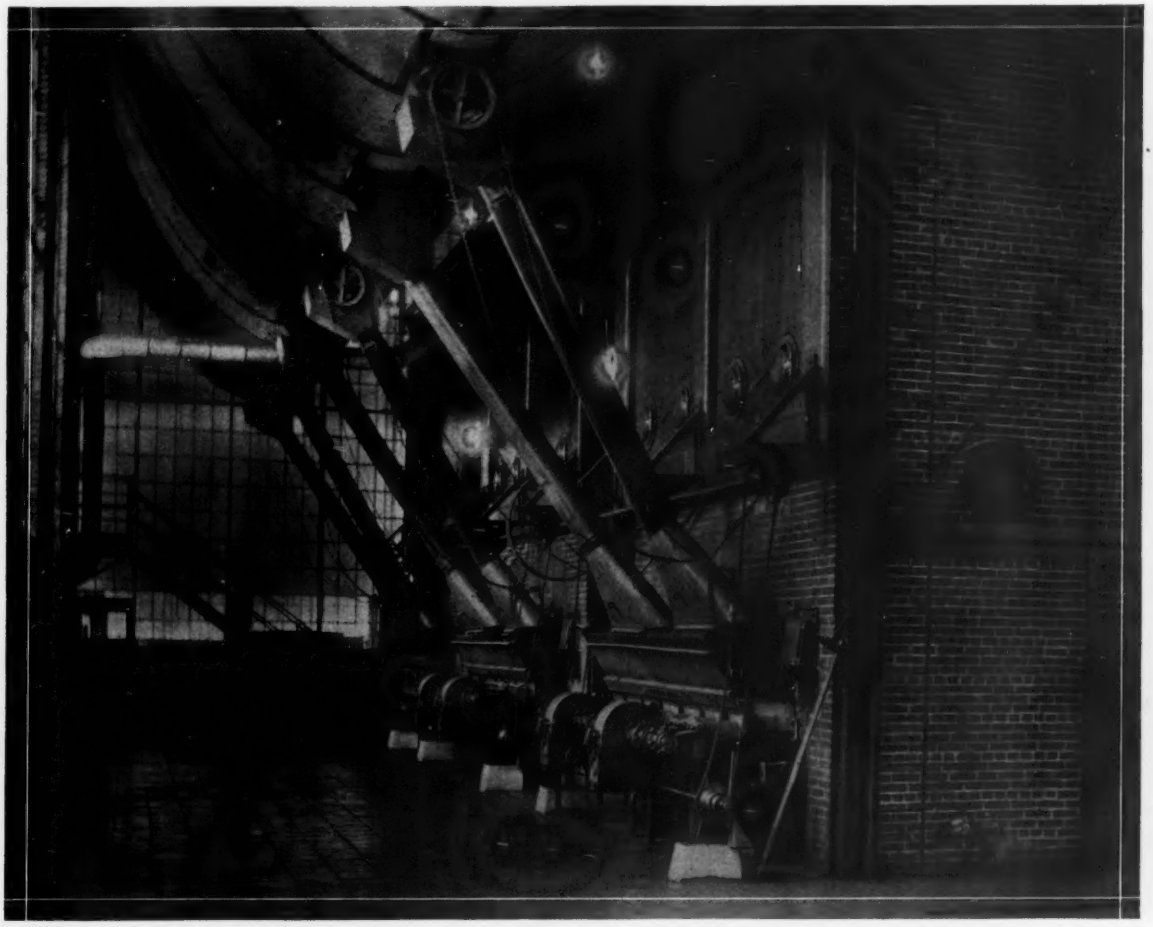


FIG. 3. VIEW IN BOILER ROOM SHOWING COAL BUNKERS, STOKERS AND FRONTS OF STIRLING BOILERS

As the load decreases, however, the plunger of the damper regulator lowers, turning the shunt field rheostat so as to increase the resistance, cut down the generated voltage and in turn reduce the speed of the blower and stoker motors.

When the boiler is operating at full load the draft is maintained at an average pressure of 5 in. of water.

Pump Equipment

All pumps employed for boiler feed and condensing service are of the centrifugal type. For the former purpose, 2 Westinghouse turbine driven, 3-stage, 180 gal. per min., and 1 Alberger motor driven 4-stage, 70 gal. per min. pumps are used and are so interconnected that any number or all of them may be operated in parallel.

The location of this equipment may be seen by referring to Fig. 5. In a separate section of the building are placed, on the first floor, all of the feed pumps. Above this is a locker and wash room for the men employed at the plant, while on the third floor is the heater room, which houses the Cochrane feed water heater mentioned above.

In Fig. 6 is shown one of the Sturtevant forced draft blowers located directly under the boiler room floor.

All ashes are removed by hand, although the installation of an ash conveyor system is under consideration and will undoubtedly be purchased as soon as additional boilers are put in, for which space has already been provided.

exciters mounted on an extension of their shafts. Each turbine exhausts into its separate condenser of the Leblanc type and located directly below the turbines in the engine room basement.

Space has been provided for an additional turbine, which may have any capacity up to 10,000 kv.a., so that

FIG. 6. FORCED DRAFT FAN IN BASEMENT

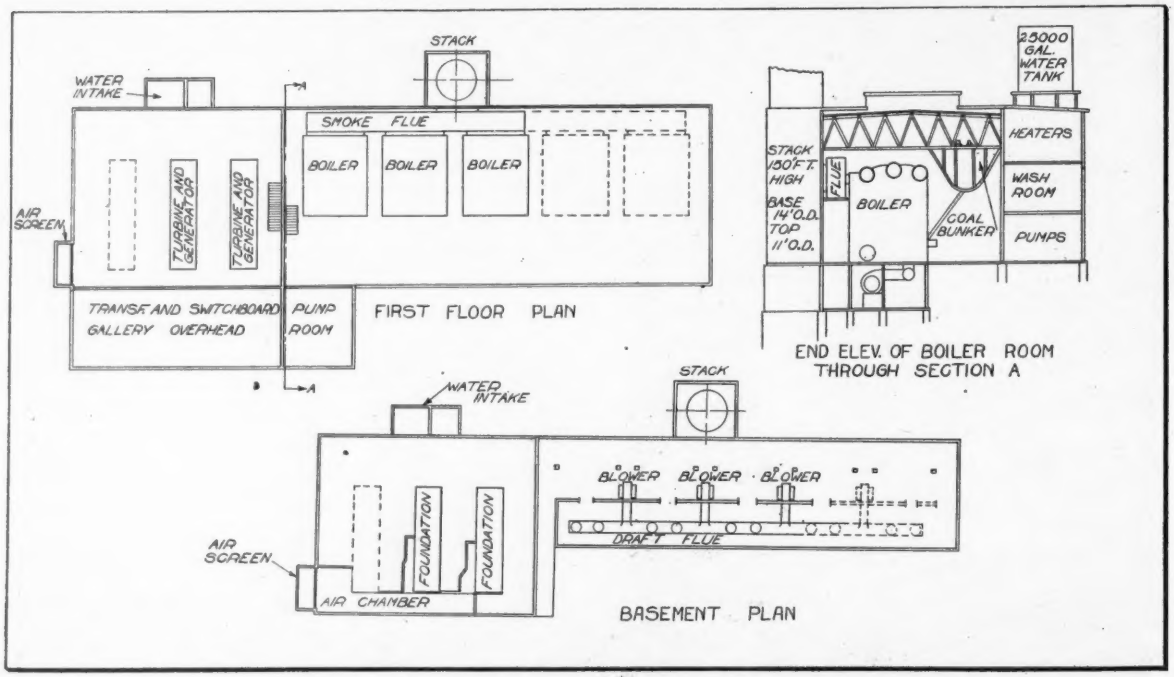


FIG. 5. PLANS AND ELEVATION OF SECURITY POWER HOUSE

Turbine Room

The equipment in this part of the plant consists of 1 2500-kv.a., 3-phase, 60-cycle, 2300-v. Westinghouse double-flow turbine and 1 1500-kv.a., 3-phase, 60-cycle, 2300-v. Westinghouse single-flow turbine, both of which operate at a speed of 3600 r.p.m. and have individual

considerable load may be added to this station without subjecting the building to any alterations.

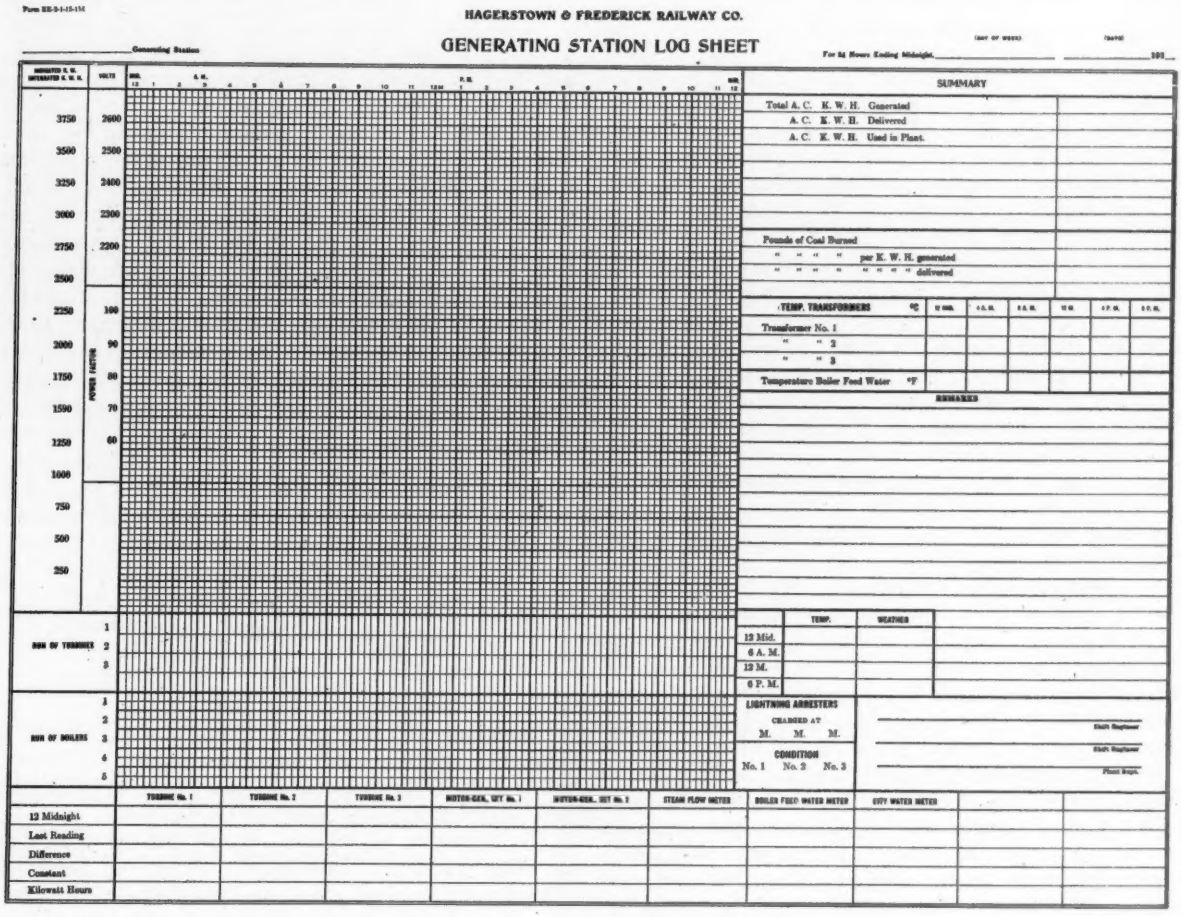
As no local distribution is cared for, the switchboard equipment is comparatively simple. Current from each machine is delivered to a 2300 to 33,000-v. water-cooled step-up transformer having a capacity rating equal to

that of the machine to which it is connected. Secondary leads from these transformers are carried to a gallery above the transformer bay, where are located all switches, bus bars, lightning arresters and other high voltage apparatus.

For local distribution, the company operates in addition to the Security generating plant, 6 substations, situated at Hagerstown, Smoketown, Braddock Heights, Frederick, Thurmont and Smithsburg, all receiving their energy from the 33,000-v. lines.

THE MATERIALS OF ENGINEERING CONSTRUCTION will receive special attention in the proceedings and discussions of the International Engineering Congress to be held in San Francisco, Sept. 20-25 next.

The field will be treated under 18 or more topics, covering: Timber resources; preservative methods; brick and clay products in general; life of concrete structures; aggregates for concrete; waterproofing; volume changes in concrete; world's supply of iron; life of iron and steel structures; special steels; status of copper and world's


HAGERSTOWN & FREDERICK RAILWAY CO.

GENERATING STATION LOG SHEET

SUMMARY

Total A. C. K. W. H. Generated
A. C. K. W. H. Delivered
A. C. K. W. H. Used in Plant.
Pounds of Coal Burned
" " " " per K. W. H. generated
" " " " " " " delivered

TEMP. TRANSFORMERS °C
Transformer No. 1
" " 2
" " 3
Temperature Boiler Feed Water °F

REMARKS

TEMP. WEATHER
12 Mid.
6 A. M.
12 M.
6 P. M.

LIGHTNING ARRESTERS
CHARGED AT
M. M. M.
CONDITION
No. 1 No. 2 No. 3

TURBINE No. 1 | TURBINE No. 2 | TURBINE No. 3 | MOTOR-GEN. SET No. 1 | MOTOR-GEN. SET No. 2 | STEAM FLOW METER | BOILER FEED WATER METER | CITY WATER METER
12 Midnight
Last Reading
Difference
Constant
Kilowatt Hours

FIG. 8. STATION LOG SHEET

STATION LOG SHEET

ALL IMPORTANT station operations are noted on a standard log sheet, a reproduction of which is shown in Fig. 8. An important feature of this sheet is the cross-sectional space at the left-hand side. From the hourly switchboard instrument readings the indicated number of kilowatts, the integrated kilowatt-hours, the generator volts and per cent of power factor are plotted, thereby giving a continuous 24-hr. operating record. Below this the running time of the turbines and boilers is also plotted.

ACCORDING TO the Iowa Engineering Experiment Station the average cost of conveying coal from car to power plant is 10c per ton when it is unloaded by hand.

supply of alloys; aluminum; testing of metals, of full sized members, and of structures.

Some 25 papers are expected for this volume, prepared by authors representing 5 different countries. The list of authors includes many of the most eminent names in this field of engineering work throughout the world.

These papers, together with discussions contributed by leading American and foreign engineers, will be published as volume 5 of the transactions, and will be illustrated with charts, diagrams and half tones. The volume will form a most valuable acquisition to the library of all engineers and others who may be interested in these phases of engineering work.

For full particulars apply to W. A. Cattell, 417 Foxcroft Bldg., San Francisco, Calif.

Expansion of Pipes

Diagrams for Finding the Expansion to be Cared For and Length of Pipe to be Used in Expansion Bends. By Reginald Trautschold

THE general tendency is to employ steam of higher and higher pressure for engines and turbines, for not only is pressure an important factor in the development of power, but the generation of high pressure steam is relatively more economical, as far as its power producing capabilities are concerned, than of the low pressure steam that until quite recently has been employed in the average engine. Superheating the steam has also become quite general. In both cases, the steam in the mains is much hotter than in the old days and this has led to the necessity of more carefully providing for expansion of steam pipes. In the modern plant, pipe connections are no longer rigid affairs but take the form of long radius curves and elbows. Loops and curves of all shapes are encountered anywhere from the boiler to the engine or turbine and, nowadays, precautions to allow for expansion on exhaust lines are also taken.

A plant originally designed to operate on high pressure steam should have its steam mains correctly laid out, but for each plant so efficiently planned there are numbers that have increased their working pressure without due consideration of the fact that with hotter steam the steam pipes will expand more than when called upon to carry steam under pressure or not as much superheat. Even the plant that is properly laid out today may not be tomorrow, when it may be decided to employ steam of still higher pressure or greater superheat. The result is that there is more trouble today, in many a plant, from leaky connections than formerly.

The calculations necessary for arriving at the correct allowance to make for expansion are neither complicated nor difficult—expansion being constant or nearly so, as far as is known, for each degree elevation in temperature. There is, of course, a certain difference of opinion as to just how much a pipe of any particular material will expand for a given rise in temperature—all authorities not agreeing upon the coefficient of lineal expansion for all materials—but for all practical purposes about a power plant the coefficients are sufficiently accurately known. Variations in the composition of the material of which the pipe is made also affect the amount of expansion, but such refinement is only of scientific interest and does not carry weight in the power plant.

Calculation of Expansion

For deriving the amount of expansion to allow for a given difference in temperature, the general formula is as shown in (I). This is simple and, knowing the coefficient of expansion of the material of which the pipe is constructed, the amount of expansion in 100 lineal feet of pipe is easily arrived at. The only confusing factor is that of temperature difference $(T-t)$. The maximum temperature, T, of the pipe is simply that of the hottest steam it will have to carry, but exactly what the minimum temperature, t, represents is not so clear. Just as a steam pipe will expand with any increase in the temperature of the steam it carries, so will it contract for any drop in its temperature. Hence t may be taken as the minimum temperature liable to occur in the locality of the power house, as the temperature of the pipe at time of installation or as the lowest temperature to which the pipe may be subject after installation. For practical purposes, however, t may be taken as 60 deg. F. In the average plant, the steam piping will never be subject to any such low temperature as may occur out in the open. In fact, it is doubtful whether the piping, once installed and the plant started up, will ever be much cooler than its mean temperature. The covering of the pipe would prevent any considerable drop in temperature, even should the steam supply be cut off, unless the plant was allowed to lie idle for some time. Sixty degrees is probably slightly lower than the average temperature of the pipe at the time it was put up, but is chosen so that any error may be on the safe side—a temperature difference based on such valuation of t being oftener too much than too little, so that the expansion allowed is practically certain to be ample. If the allowance is slightly too much, no harm is done; while, should it be only slightly too little, considerable trouble might arise from leaky connections.

$$E = 1200 \times C \times (T-t) \quad \text{(I.)}$$

E = Expansion in inches per 100 ft. of pipe.
$(T-t)$ = Temperature difference in degrees Fahrenheit.
C = Coefficient of Lineal Expansion.
= 0.000,011,1 for Bronze.
= 0.000,010,5 for Drawn Brass.
= 0.000,009,5 for Copper or Cast Brass.
= 0.000,006,8 for Wrought Iron.
= 0.000,006,7 for Steel.
= 0.000,006,5 for Cast Iron.

To simplify calculations still more, formula (I) is plotted in the Reference Tables, for every 10 ft. length up to 110 ft. The use of such visual presentation greatly expedites calculations and, sufficient accuracy being secured, reduces the chances of error in figuring. As showing the convenience of the chart, the necessary allowances to make for expansion in a case that is typical of common problems in practice will be figured.

An establishment will be considered which has been operated on noncondensing engines employing steam at 100 lb. gage pressure—say 109 lb. at the boiler—and all piping of standard steel pipes. The total length of the 4-in. steam mains is about 100 ft. and of the 8-in. exhaust piping about 50 ft. The water that has to be used possesses certain qualities which cause considerable corrosion of the steel pipes and it is thought that wrought-iron pipes might stand-up better. More power also being required, it is decided to remodel the plant to make it condensing at the time it is repiped. Under the new conditions, steam is to be employed at 175 lb. gage pressure—say 181 lb. at the boiler—and 125 deg. F. superheat carried. The vacuum it is planned to carry is 28 in., the back pressure in the old plant having been 6 lb.

In working out this problem, we go to the chart for lineal expansion of steam pipes. The first step is to

find the amount of expansion in the original layout. With boiler pressure at 109 lb. gage, the temperature from the steam tables is 343.6 deg., and considering the temperature of the atmosphere as 60 deg., the temperature change will be 343.6 — 60 or 283.6.

Starting, therefore, with 283 on the lower left-hand axis of the diagram, we pass vertically to the diagonal line for steel pipe, then horizontally to the right, and find that expansion per 100 ft., as indicated on the diagram, would be about 2¼ in. In this case, the pipe is 100 ft. long, so that this would be the total expansion.

For the exhaust pipe, the temperature, at 6 lb. gage pressure, is found to be 229.8 deg. The difference between this and 60 deg. is 169.8. Starting, therefore, with practically 170 deg. on the lower left-hand axis, and passing upward to the line for steel pipe, we find that our expansion would be 1.39 in. for 100 ft.

If we now pass on through the vertical axis to the intersection with the 50-ft. diagonal line, then downward to the right-hand horizontal axis, we find the expansion is practically 0.7 in., so that, in the old plant, the expansion to be cared for on the steam pipe is 2¼ in., and on the exhaust pipe, 0.7 in.

Going, now, to conditions for the new plant, we are to have 181 lb. gage pressure, which gives us 380.1 deg. F., and with 125 deg. added for superheat, gives a maximum temperature of 505.1 deg. Subtracting 60 from this, leaves 445.1 deg. as the temperature difference.

Going to the chart and working as before, we find that for wrought-iron pipe, with a temperature difference of 445 deg., the expansion per 100 ft. will be 3.65 in., which, as this pipe is 100 ft. in length, will be the total expansion.

For the exhaust pipe, at 28 in. vacuum, the temperature will be 100 deg., and subtracting 60 from this, gives us 40 deg. as the temperature difference. This difference is lower than that shown on the diagram, hence we shall have to work by proportion.

For a temperature difference of 80 deg., we find that the expansion will be practically 0.7 in. on 100 ft. length, and passing horizontally to the 50-ft. line, and vertically downward, the expansion would be 0.35 in. for a 50-ft. length. With 40 deg. temperature difference, the expansion would be half this, or 0.175 in., so that in the final set of conditions, we must provide for an expansion of 3.65 in. in the steam and 0.175 in. in the exhaust mains.

For satisfactory accommodation of expansion in the steam mains of the new plant, 1⅜ in. more expansion should be allowed for than in the old arrangement. For the new exhaust line, about ½ in. less expansion need be provided than was necessary for the plant when operating noncondensing. As an accident might easily cause a loss of vacuum, however, it would be advisable to have the new piping make the same allowance as the old, particularly as the saving in piping by eliminating ½ in. of allowable expansion would be negligible and it would be just about as cheap, possibly cheaper, to have the new piping follow the lines of the old.

Though the corrections to be made in the piping for the new plant do not seem to be very marked, the correction required for the steam main, if not made at the time of remodeling the plant, is quite serious enough to cause a good deal of inconvenience, trouble and expense from leaky connections.

Expansion Bends

For taking up expansion in lines of steam piping, various forms of bends may be used. When this method is adopted, the question arises, "How long should the bend be made?"

Evidently this depends on the amount of expansion to be cared for, and the size of the pipe, since a given length of small pipe can safely bend more than a length of larger diameter.

The pipe bend acts simply as a spring, the distributed bending serving to take up the motion of the end of the run of pipe; as a certain amount of motion can be taken up by each foot of the pipe, it follows that the longer the pipe the greater is the motion that can be cared for. So far as the spring per foot is concerned, it makes no difference whether the pipe is straight, a circle, a U bend or a reverse curve. In any case the pipe acts like a beam with an end load.

The relation becomes simple and can be expressed by a series of curves as given in the Reference Tables.

In making up a bend, the strain on the metal in bending makes it unwise to use a radius less than 5 pipe diameters, although in extreme cases a smaller is used as shown in the Reference Table furnished by the Best Mfg. Co.

The expansion as shown in the Reference Tables is based on a fiber stress of 12,000 lb. in the pipe, which gives a factor of safety of 5 to 6 depending on the quality of the metal.

Applying these curves to the problem worked out previously, we have for the steam main, which is 4-in. pipe, to provide for an expansion of 3.65 in. Starting on the diagram with the left-hand axis, passing horizontally to the intersection with the 4-in. curve, and vertically downward, we find that practically 28 ft. of pipe should be made into a bend to take care of this amount of expansion.

From the table of radius and straight ends, we find that the smallest radius permissible is 1 ft. 7 in., and that 5 in. should be provided at each end of the curve for satisfactory results. The total length of the pipe required, then, would be 28 ft. 10 in., and the smallest radius of curvature which should be used is 1 ft. 7 in., any larger radius being permissible.

For the exhaust pipe, which is 8 in., we have to care for approximately 0.2 in. expansion. This is an amount so small that the curve for the 8-in. pipe has not been carried down into that region, but by inspection and a prolongation of the curve, we find that a piece of pipe about 10 ft. long would be required to take care of this, and from the table, 8 in. should be allowed at each end, making a total length of 12 ft. 4 in.; the least radius of curvature, 3 ft. 4 in.

It will be seen from this discussion and problems, that the curves herewith give a complete system for properly determining the amount of expansion to be cared for in any piping system, and for deciding on the amount of pipe required in a pipe bend, and the least radius of curvature. The shape of the pipe bend can be made such as will most conveniently fit into the plant. If the piping is so arranged that a straight piece of the required length can bend to take up the expansion, of course no special expansion piece is necessary.

Vandergrift Boiler Tests*

SUMMARY AND DISCUSSIONS OF TESTS ON A RECENT TYPE OF CHAIN GRATE STOKER AND NEW METHOD OF BAFFLING STIRLING BOILERS. BY JOHN A. HUNTER†

AT the Vandergrift Works of the American Sheet & Tin Plate Co., an installation has been made of a comparatively new type of chain grate stokers, and of Stirling boilers with a new method of baffling. Tests of one of these units showed such high efficiencies that it was thought the results would be of general interest.

The installation consists of 7 Class M-22 Stirling boilers, nominally rated at 600 hp., containing 6032 sq. ft. of water heating surface and 396 sq. ft. of superheating surface. An individual unlined steel stack, 72 in. diameter and 150 ft. in height above the breeching produces the draft.

Each boiler is provided with one type "L" Green Engineering Company stoker, 10 ft. 6 in. wide by 12 ft. long, containing 126 sq. ft. of chain surface.

The boilers are equipped with soot blowers having stationary and rotary nozzles located at the points shown on Fig. 1, which also shows the general arrangement of the equipment.

The water-back, designed by the Babcock & Wilcox Co., is to be noted as differing from the ordinary water-back in that it has 2 separate water boxes placed one directly over the other and each is connected to the mud drum and front steam drum, thereby insuring positive circulation through each box.

All tests were conducted according to the Code of the American Society of Mechanical Engineers.

The method of starting the tests was as follows:

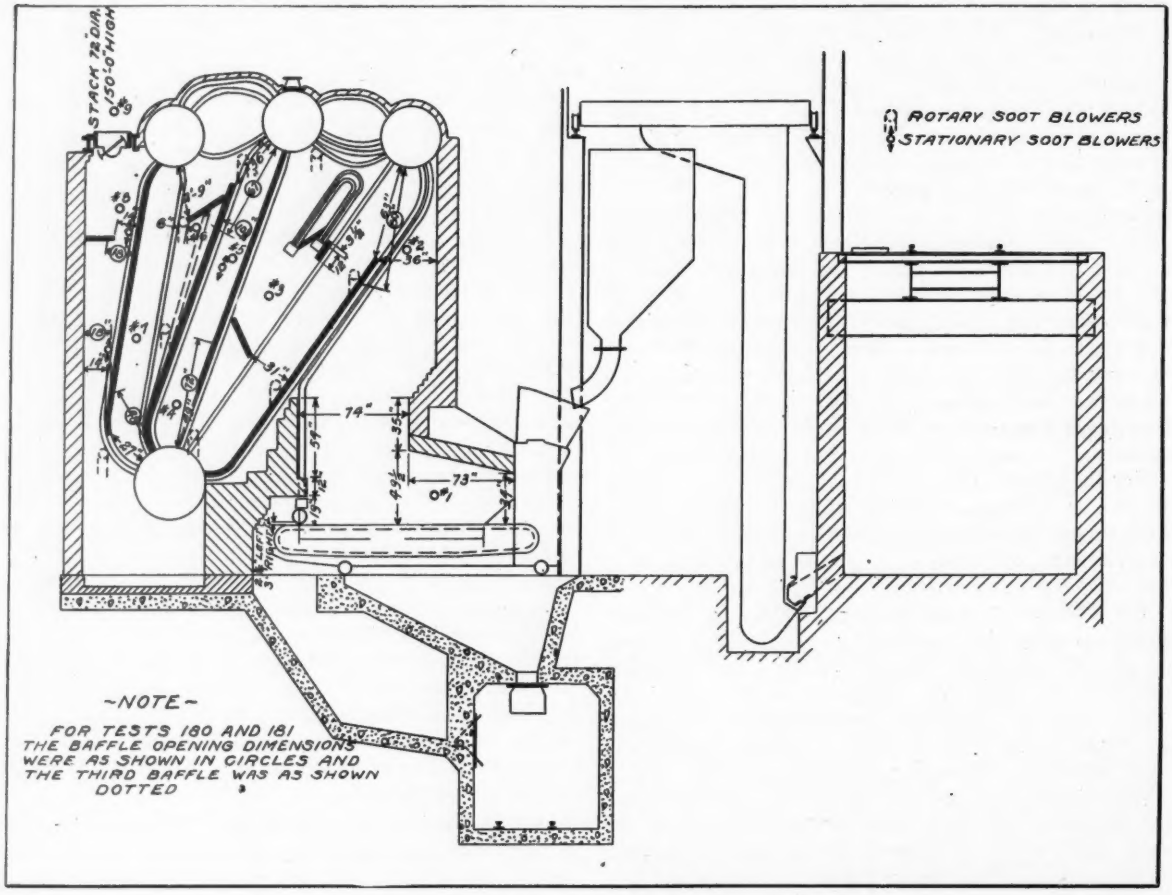

STACK 72 DIA. 150'-0" HIGH
ROTARY SOOT BLOWERS
STATIONARY SOOT BLOWERS
74"
73"
~NOTE~
FOR TESTS 180 AND 181 THE BAFFLE OPENING DIMENSIONS WERE AS SHOWN IN CIRCLES AND THE THIRD BAFFLE WAS AS SHOWN DOTTED

FIG. 1. CROSS SECTION OF BOILER SETTING AT VANDERGRIFT WORKS

Weights of water and coal and all the other data were started in the regular manner as soon as the testing gang arrived. The height of the water in the suction tank and the boiler gage glass were carefully noted. The records of the weights of the coal were started with the stoker hopper full and scraped over level. At the end of each hour the same conditions of water and coal levels were brought about. By this method, the exact weights of coal and water for each hour were obtained. As this boiler was connected into the main header on which the load was very variable, it was not always possible to keep the water level in the gage glass constant, although there was an attendant for the operation of the feed pump.

*Abstract of paper read before the Engineers' Society of Western Pennsylvania.

†Steam Engineer, American Steel & Tin Plate Co.

The stoker operator immediately took charge of the stoker and as soon as uniform conditions, under which the test was to be conducted, were obtained the test was started at the end of this hourly period.

A sufficient time was allowed between all tests to establish uniform conditions under which the next test was to be conducted.

All scales were tested daily. All thermometers, gages, etc., were calibrated and corrections made when necessary.

After making tests Nos. 180, 181 and 182 it was decided to put on 2 gangs in order to make the tests of longer duration and thus avoid the possibilities of error due to the amount of fuel on the stoker at the start and finish of the tests.

For tests Nos. 180-182, the gate was about 6¾ in. above the pusher and in tests Nos. 183-189, the gate was about 7½ in. above the pusher. On test No. 182, the first test made in connection with the Babcock & Wilcox Co., about the same efficiency was obtained as in the previous tests which were made in connection with the Green Engineering Co. After this test a change was made in the manner of operating the stoker, which

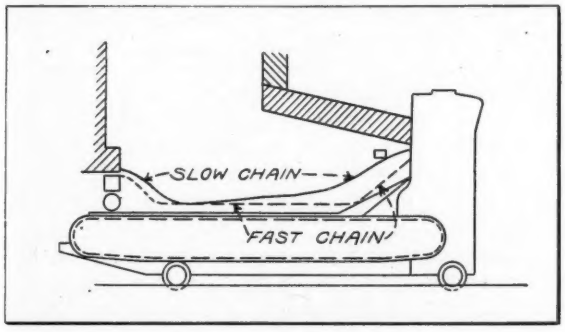


FIG. 2. COMPARISON OF FUEL BED IN SLOW CHAIN AND FAST CHAIN METHODS OF OPERATION

has been designated as the "Slow Chain" operation to distinguish it from the old method, which is called "Fast Chain." The "Slow Chain" operation was used on the rest of the tests.

Referring to the diagram, Fig. 2, the area under the dotted line shows the character of the fuel bed with the "Fast Chain" method of operation. It is to be noted that the depth of the fuel bed is about the same over the entire grate except near the waterback, where it is piled up. The character of the fuel bed with the "Slow Chain" method of operation is shown by the solid line on the diagram. It is to be observed that the fuel bed is quite deep on the front part of the stoker and that it gradually thins down until it is about the same depth as the fuel bed with the "Fast Chain" operation at a point about 3 ft. ahead of the water-back. It is also piled up on the water-back as shown. By maintaining this kind of a fuel bed it was expected that the combustible in the ash would be reduced and that the smoke, of which there was quite an amount with "Fast Chain" operation, would also be reduced.

With the "Fast Chain" method the distillation of the volatile gas of the coal takes place very rapidly and a large portion of it passes off in the flue gas unburned, as is evidenced by the amount of smoke observed. The coal does not remain on the grate a sufficient length of time to have its carbon content completely burned. With the "Slow Chain" method the distillation of the volatile gas takes place quite slowly. All this gas is driven off by the time the thin portion of the fire is reached. As there was practically no smoke except at very low ratings, it is thought that practically all the volatile gas was burned. The thin portion of the fire allows an excess of air to be drawn through the fuel bed at this point, which completes the combustion of the carbon.

A curve, Fig. 3, has been plotted showing the relation between per cent of boiler rating and combined boiler and furnace efficiency. The curve shown in solid line refers to the actual efficiencies obtained from all the tests. The points below 150 per cent capacity are for tests run with the "Slow Chain" method of operation; the points above 150 per cent capacity are with the "Fast Chain" method. For this particular installation with the draft available the solid curve represents the capacities and efficiencies which can be obtained.

About 150 per cent of rated capacity is the maximum which can be obtained from this boiler with the "Slow Chain" method of operation, so that when capacities

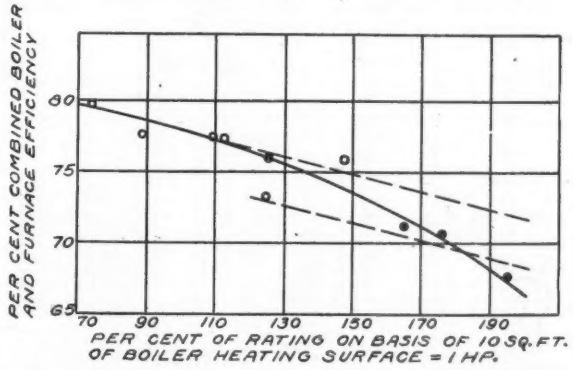


FIG. 3. RELATION BETWEEN BOILER RATING AND EFFICIENCY

above 150 per cent are desired, it is necessary to increase the chain speed and change the operation to approach the "Fast Chain" method. It is thought that with sufficient draft the curve would have followed the upper dotted line. The lower dotted line represents the efficiency which can be obtained with the "Fast Chain" method of operation. The dotted lines are parallel and the difference between them represents the difference in efficiency which is obtainable by the 2 methods of operation.

By taking indicator cards from the engine driving the stoker, it was found that it required an average of 0.72 i.hp. to operate the stoker. Allowing 80 lb. steam per i.hp. hour, the following percentages of steam generated are required for the operation of the stoker: At 100 per cent rating, 0.35 per cent; at 150 per cent rating, 0.23 per cent, and at 200 per cent rating, 0.17 per cent. These quantities are so small that for all practical purposes the efficiencies obtained can be considered as net efficiencies.

Discussion

In the discussion which followed the presentation of this paper, Dr. D. S. Jacobus, advisory engineer, The Babcock & Wilcox Co., New York, stated that it

usually pays to make an investigation rather than perfunctory tests and to depart considerably from what may be considered standard practice in order to note the results. The slow chain method was a wide departure from the ordinary way of operating a chain grate, and the improved results secured by it point out a field for further investigation in which tests could be made to determine whether the gain will hold for all classes of fuel.

John Wolff, chief engineer, The Cleveland Electric Illuminating Co., Cleveland, Ohio, stated: "The results obtained by Mr. Hunter confirm our own. For some months past, we have been operating our station in a

TABLE I. RESUME OF PRINCIPAL RESULTS

Test No.	Length Hrs.	Per Cent. Rating	B.T.U in Coal	Per Cent. Ash in Dry Coal	Efficiency	Chain Speed In. per Min.	Per Cent. Combustible in Ash	Temp. of Flue Gas Deg. Fahr
180	10.07	165.1	13229	12.72	71.16	4.64	33.14	598
181	10.00	194.8	13616	10.55	67.69	4.93	37.65	617
182	12.00	176.1	12900	14.16	70.54	....	41.63	520
183	24.00	112.4	13327	12.07	77.28	1.99	24.67	442
184	26.00	124.7	13567	10.44	73.19	2.19	34.89	474
185	35.00	109.6	13226	11.54	77.45	1.58	21.23	449
186	24.00	125.7	13421	11.20	76.00	1.98	23.71	499
187	36.00	88.8	13279	11.72	77.67	1.59	21.49	425
188	24.00	147.8	13411	11.78	75.86	2.00	17.86	550
189	20.00	74.0	13521	10.90	79.82	1.59	20.67	417

TABLE II. AVERAGE DRAFTS

Test No.	Draft In. of Water at Points Located on Fig 1.								
	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No 7	No. 8	No. 9
180	.253	.267	.302	.483	.493	.506	.602	0.774	1.111
181	.347	.382	.428	.634	.647	.673	.791	1.003	1.023
182	.194	.270	.282	.408	.432	.557	.612	0.854	0.905
183	.178	.124	.135	.218	.215	.240	.281	0.352	0.855
184	.228	.206	.235	.321	.324	.364	.408	0.512	0.968
185	.197	.141	.154	.245	.240	.267	.313	0.387	0.913
186	.246	.258	.271	.386	.390	.442	.492	0.626	1.000
187	.078	-.020	-.007	.062	.044	.046	.086	0.121	0.770
188	.320	.355	.377	.514	.532	.619	.672	0.889	1.140
189	.051	-.050	-.034	.029	.009	.005	.043	0.047	0.426

TABLE III. COMPUTED RESULTS

Test No.	Factor of Evaporation	Equivalent Water Evaporated into Dry Steam F. & A. 212° Fahr. per Hour	Equivalent Evaporation F. & A. 212° Fahr. per Lb. Dry Coal	Equivalent Evaporation F. & A. 212° Fahr. per Sq. Ft. Boiler Heating Surface	Horse Power Developed	Per Cent. of Rated H.P. Developed on Basis of 10 Sq. Ft. of Heating Surface Per H.P.	Combined Efficiency of Boiler and Furnace
180	1.2393	34354	9.70	5.70	995.8	165.1	71.16
181	1.2424	40534	9.50	6.73	1174.9	194.8	67.69
182	1.2426	36654	9.38	6.08	1062.4	176.1	70.54
183	1.2368	23382	10.61	3.88	677.7	112.4	77.28
184	1.2453	25959	10.23	4.30	752.4	124.7	73.19
185	1.2313	22810	10.56	3.78	661.2	109.6	77.45
186	1.2410	26151	10.51	4.34	758.0	125.7	76.00
187	1.2428	18472	10.63	3.06	535.4	88.8	77.67
188	1.2422	30751	10.48	5.10	891.3	147.8	75.86
189	1.2682	15394	11.12	2.55	446.2	74.0	79.82

somewhat similar manner and have named this method the 'Slow Drive,' reference here being to the speed of the line shaft controlling the stokers, which in the end is responsible for all the other stoker movements.

"We found, for ordinary everyday operation, that we could establish certain fixed conditions of fuel feed, which condition required no change from one month's end to the other. Thus, a positive forward movement of the pusher plate of 2½ in. per stroke, a definite forward movement of the ratchet wheel operating the shaft, which in turn operates the pusher plate. This movement expressed in terms of number of teeth fed per revolution of line shaft is four. The only variable entering into the scheme is the speed of the grate, which ordinarily is fed at the rate of 2 notches.

"With the conditions established as above, it is possible to take care of momentary variations of load by simply manipulating the dampers. For other loads greater than the average and less than the peak a slight increase of line shaft, which controls all stoker movements, only is necessary. For peak work, the speed of the chain only is increased, which is done by changing the chain feed from 2 to 3 teeth of the ratchet. The average speed of the line shaft is 35 r.p.m. With the manipulations as outlined we can maintain a uniform steam pressure; we can maintain a water level with little or no fluctuation, requiring few adjustments of the feed valves. It may be said here that we depend on hand regulation for the feed water level and do not employ any high or low water alarm. Further, the furnace is at all times charged with sufficient fuel to supply any demands made on it, and no time or heat is lost in bringing banked or cold boilers into action.

"Possibly the most important advantage, is the extreme confidence the operators feel in their ability to meet and handle all situations. They find time now to help the fellow with the Orsat discover and locate CO_2, the existence of which in large quantities I believe they have always doubted; at least, they no longer mumble 'it can't be done.'"

T. A. Marsh, chief engineer, Green Engineering Co., Chicago, stated that "it has been well known for years that higher capacities could be obtained with thin fires, but best efficiencies were to be obtained with thick fires." In chain grate practice, however, "thick and thin" referred usually to 8-in. depth of fuel beds as compared to 5 in.

"The method of firing described in this paper, however, is not simply a thicker fire. The fuel bed is of an entirely different form and the characteristics are different.

"As a matter of interest the writer has prepared curves, Fig. 4, showing the combustion rates per unit of draft obtained with the 'Fast Chain' method as compared with the 'Slow Chain' method. The different location and slope of these curves demonstrate that the 2 methods are entirely distinct.

"With the 'Fast Chain' method, a combustion rate of 30 lb. of dry coal per sq. ft. of grate surface per hour was obtained, using a furnace draft of 0.30 in. water column; with the 'Slow Chain' method the same draft was used for a combustion rate of only 21 lb. The draft below the damper was in each case 0.90 in.

"The 2 curves are similarly apart throughout their entire range. An analysis of the difference in results obtained by the 'Slow Chain' firing method appears to be as follows:

1. For the same combustion rate a chain speed of less than half.
2. A furnace draft of much greater intensity.
3. Lower flue gas temperatures.
4. Lower percentage of combustible in the ash.
5. Higher percentage CO_2.
6. Practical elimination of smoke.
7. Increased capacity, due to increased efficiency at a given combustion rate.

"The question is sure to arise regarding the application of this knowledge to existing plants.

"The new method of baffling should be considered cautiously; some classes of boilers are better adapted to the standard style. Soot removal, draft losses and capacity obtainable must all be considered and proper provision made.

"The extent to which this 'Slow Chain' method can be applied to standard chain grates is questionable. It is evident that much more is involved than simply a thicker fire. Excessively thick fires on chain grates usually result in a surface ignition, low furnace temperature and uneven fuel bed conditions.

"It might be possible to design furnaces for very thick fuel beds, but it does not appear possible to obtain the same characteristics of the fuel bed with standard chain grates as are shown in this paper.

"The position of the coking plates and their action are unquestionably of utmost importance, and while it is certainly hoped that these principles will apply in a measure to standard chain grate practice, the indications are that the application is limited to the coking coal L Type stoker."

J. E. Bell, engineer, The Babcock & Wilcox Co., New York, says "the question of the loss of draft through this Stirling boiler has been raised 2 or 3 times and the apparent inconsistency in the difference in suction between the damper and the furnace at low ratings is undoubtedly perplexing to almost anyone who has not had much to do with this form of baffling.

"The furnace in this boiler being unobstructed, contains a column of very hot gas, some 18 ft. high. Considering the difference in temperature, the draft produced by such a column is about equivalent to that produced in a stack 50 to 60 ft. high with ordinary flue gas temperatures and is enough, if the outlet from the boiler is restricted and the weight of gas passing through the setting is small, to produce a pressure at the top of the furnace; this pressure may be sufficient to force the gas through the boiler and out the damper opening.

"The furnace is the Class W Stirling boiler, such as is installed at the Delray plant of the Detroit Edison Co. and in the Municipal Electric Plant at Cleveland, somewhat similar, but higher. In some tests made at Delray a pressure was observed at the top of the furnace of 0.05 in., while there was a suction over the fire of 0.25 in. At the low rating tests at the Municipal plant in Cleveland, the suction in the furnace was about 0.05 in., and at the top of the furnace a pressure sufficient to produce a pressure under the damper of 0.1 in. Each pass, of course, in the boiler acts in much the same way, the down passes tending to increase the draft loss and the up-passes to diminish it."

The Author: Relative to the low stack draft in test No. 189, in this test it was necessary partially to close the stack damper in order to get the low rating desired. In all of the other tests the draft was controlled by the boiler damper. The point at which the stack draft was taken was below the stack damper so that the stack draft in this test was really not the total draft available.

W. H. White, superintendent boiler department, Vandergrift-Apollo Works, American Sheet & Tin Plate Co., said: "I can explain, from personal observation, how we handle our load at Vandergrift. I was always in favor of a fast grate speed—say about 4 in. grate speed per minute. That used to be our regular practice until after this series of tests were made with a slow grate speed, which we found gave us better results than we were able to get with the fast grate speed. The slow grate will require more careful attention, on the part of the stokerman, than a fast grate. If the fire gets away from a good operating condition, through holes in the fire, it will take the stokerman more time to get it in good condition again, owing to the slow grate speed.

"We never get peak loads, but at times our blooming and bar mill engines are shut down and from 6000 to 7000 hp. will drop off and may remain off for 10 min. to one hour. When they start up they will run the same as if they had not been stopped. That is the time we find it hard to keep our steam pressure from falling.

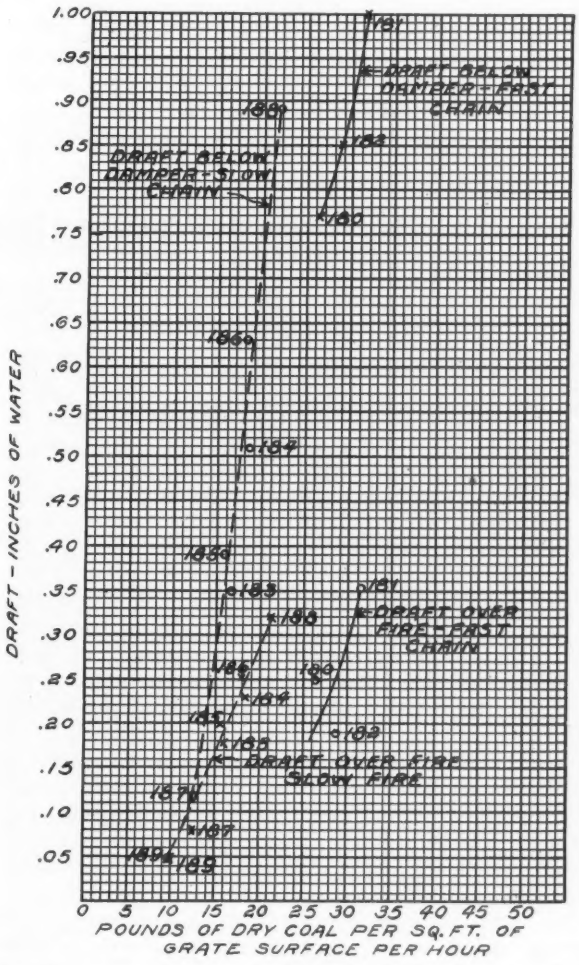


FIG. 4. COMPARISON OF COMBUSTION RATES OF FAST AND SLOW CHAIN METHODS

"All of our Stirling boilers are equipped with General Electric Company steam flow meters. I have often watched the flow meter and tried to make one boiler pick up and deliver a sudden increase of steam. The chain would be running at the slow rate, carrying a deep fire, with the flow meter indicating 700 hp., with a draft of 0.60 in. water. It is easy to increase the output to 800 hp. by simply increasing the draft to 0.80 in. water. More draft will give greater horsepower; but, of

course, you will have to watch and not keep this high draft on more than 5 or 6 min. without firing more coal to make up for the higher rate of consumption.

"Besides the 7 Stirling boilers just referred to, we have another boiler house fitted with older and less efficient boilers, and we use these to take the variable load when the bar mill goes off and on suddenly. The steam pressure controls the dampers and the grate speeds on these old boilers."

R. H. Danforth, professor of mechanics and hydraulics, Case School of Applied Science, Cleveland, Ohio, states: "What apears to have been actually accomplished by the change in operation from so-called 'Fast Chain' method to 'Slow Chain' is to concentrate the distillation and carbon combustion on the front ⅔ of the grate, running a spot near the ash dump practically free from everything except hot ash, which acted as an excellent preheater for air coming through from below.

"The distillation and partial combustion of the coal being accomplished near the front end of the arch, the resultant gases would pass back in an approximately horizontal direction, strongly heated by the radiation from the arch, and would meet the vigorous vertical current of preheated air, which, owing to its difference in direction, would be quite completely mixed with the combustible gas, with resultant intense combustion in the upper part of the fire-box amounting almost to a continuous explosion, as is shown by the fact that draft readings for tests 187 and 189 with damper nearly closed show outward instead of inward pressures at gage No. 2.

"This analysis is corroborated by the statement that the 'Slow Chain' operation could not be used beyond 150 per cent rating. The reason was either that gate would not allow the feeding of a sufficiently heavy layer of coal so that more than about 28 lb. per square foot per hour could be burned, or what is more likely, the lower portion of the extremely heavy bank of coal did not get hot enough to start distillation until it arrived near the center of the fire, and as this distillation would require the greater part of the available air, the carbon would pass over with the ash unburned."

Efficient Operation of Boiler Rooms

METHODS AND ROUTINE IN AN INDUSTRIAL PLANT EQUIPPED WITH WICKES BOILERS AND MURPHY STOKERS

IN the preparation of this series of articles on the Efficient Operation of Boiler Rooms, so many power plants were visited, all of which were achieving results above the average, that the writer does not propose to give a complete description of each plant visited, but has selected a number which are typical of their classes, having equipment well adapted to the work. In some cases, however, suggestions will be made for improvements, both in operation and additional equipment which will make for convenience and economy. In view of this treatment of the subject, the writer refrains from publishing the name of the plant in order that no injustice may be done the engineer or owner of the plant, at the same time giving the readers the benefit of our investigations.

In a plant manufacturing paper are installed 6 Wickes water-tube boilers, 3 of which are rated at 300 hp., 1 at 400 hp., and 2 at 250 hp., all carrying steam at 125 lb. pressure. Murphy dutch oven furnaces serve all these boilers, but all the proportions are not those recommended by the manufacturer; this change from standard was necessary in order to preserve the symmetry of the plant, and under the conditions of operation the settings have proved well adapted. One change which has proved of advantage in lengthening the life of the arch over the fire was made in the proportions of the air duct which caused a more rapid circulation at the center than the sides, and brought the air farther back over the center. This construction has given the arch a life of over 2 yr., while with former construction 1 yr. 9 mo., was the maximum. The change also overcame the difficulty of the coal in the furnace hopper igniting.

The ratio of heating surface to projected grate area varies from 60 to 1, to 70 to 1, the latter being preferred by the engineer as the load on the plant is very regular and the boilers are run at 115 to 125 per cent of their rating and with the 70 to 1 ratio the fires must be kept in good condition, almost to the forcing point, in order to supply the steam; yet with this proportion the firemen are able to hold the load on the boiler at 168 per cent of the rating with the natural draft available. The average air space in the grates is 40 per cent, but the engineer thinks this is too large for the kind of coal being burned as he can secure better results when the air spaces have become filled somewhat with ashes.

Draft is regulated by hand and kept at about 0.5 in. on the boiler side of the damper and 0.2 in. over the fire, the fuel bed averaging 6 in. in depth. With this distribution of draft the capacity of the furnace is 30 lb. of coal per square foot of projected grate area per hour. The engineer is not an advocate of automatic damper regulators, particularly where the load is as constant as it is here, he prefers to train his firemen to recognize the appearance of an economical fire and to regulate the draft accordingly; the value of such a training is shown by the fact that in 8 yr. only 2 arch plates have been replaced.

When holes burn through the fire bed, they are covered by shaking the stoker or by using the bar. When clinkers form, a steam jet is turned on beneath the grate for a short time to prevent fusing, and when hard they are removed. To prevent this trouble, however, the engineer buys coal which forms the least amount of clinker.

Fairmont, W. Va., slack is used and comes to the plant in railway cars on an elevated track, but must be shoveled to the bunkers, which are directly in front of the boilers and on the same floor level, so the coal is carried in wheelbarrows to the stoker hoppers. No provision has been made for weighing the coal regularly, but this could easily be done on platform scales by the coal

wheelers on their way from coal bunkers to boilers, and this method is used during tests which are conducted occasionally and serve to guide the firemen during regular operation.

Ashes are removed 4 times in 24 hr., by hand, being carried away in wheelbarrows.

Baffling of the boilers is the standard employed with Wickes boilers, consisting of one baffle between the 2 center rows of tubes extending to within 3½ ft. of the upper drum. The settings are of common brick with firebrick lining, and when it is suspected a crack has developed, a man is sent with a torch or candle to examine suspected parts, or the damper is closed suddenly when the fire is burning in good condition and the leaks are shown up by the issuance of smoke. When found, holes are stopped up with fire clay mixed with waste or asbestos rope.

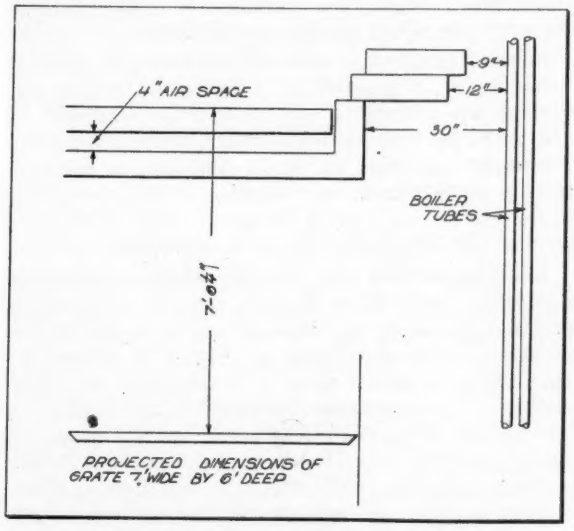


FIG. 1. FURNACE PROPORTION IN 300-HP. BOILER

On each of the boilers are 2 4-in. Crane safety valves, which are raised from their seats regularly once a day. No 2 valves are set to pop exactly at the same pressure; but all come within the limit of 5 lb., which is entirely safe and gives the firemen a chance to control their fires and prevent the blowing of more than one or two of the valves.

Standard practice is followed in the construction of the boilers with regard to handholes and manholes, but where pipes enter the shell an extra piece is riveted on in preference to the nipple ordinarily employed. In Wickes boilers, a water baffle extends about half way back in the upper drum at about the water level and prevents water from being thrown up into the steam space.

Returns from the heating system constitute the great share of the feed water; makeup water is taken from a river and a small amount of compound is used. Water level is automatically controlled by feed water regulators and the columns are provided with high and low water alarm features, while the gage glasses have self-closing safety cocks. The water columns are blown down and tried by the oncoming attendant in the presence of the man going off duty at each change of shift.

While the original feed water connection was to the rear of the upper drum, this has been changed to the lower drum. With the former piping, considerable scale formed in the back tubes and it was difficult to determine the water level from the gage glass; neither of these troubles are experienced when feeding to the lower drum, except when forcing the boiler, the water level is somewhat "cranky."

The blowoff piping is shown in the sketch; but the boilers are never blown down while running, this connection being used only while cleaning. Boilers are

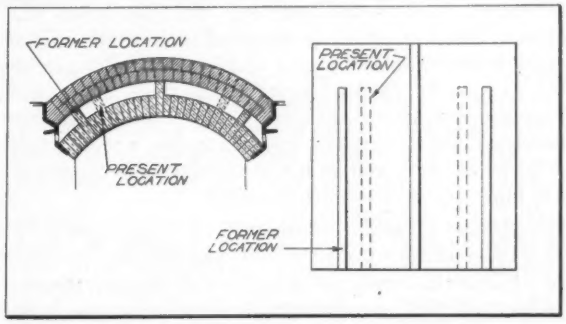


FIG. 2. AIR DUCT IN FURNACE ARCH

operated 24 hr. a day, except Sunday, when only one is needed, so at 6 p. m. on Saturday all boilers but one, which has just been cleaned and put into service, are shut down and allowed to stand until Sunday morning, when the bottom blowoff is opened and the top feed is started, feeding cool water. It takes approximately 1 hr. for the boiler to cool sufficiently, then the cap is taken off, the blowoff connection and the washout pumps are started, and the boiler is washed until the water from the blowoff is clear, when the cap is replaced on the blowoff and the boiler filled ready to start Sunday even-

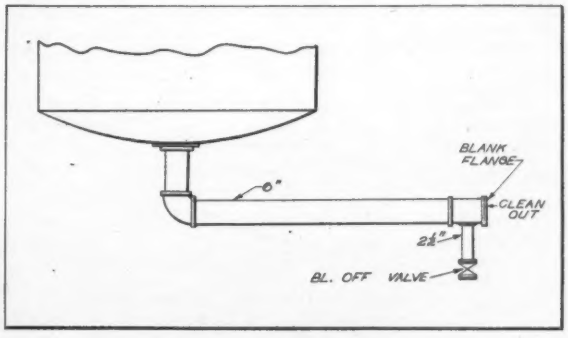


FIG. 3. BLOWOFF PIPING

ing. By this system the boiler is washed and given a fresh supply of water once a week. One boiler is out of service for 1 week after 6 weeks' run, when it is thoroughly washed and examined, and once in 3 months all tubes are cleared of scale with a turbine, plates are scraped and the boiler given a thorough inspection.

As a result of this practice the boilers are operated regularly at 115 to 125 per cent of their rating with but very little formation of scale and no danger from burned or bagged tubes. In 8 yr. only 1 new tube has been used, which is sufficient proof of the value of the system.

Soot is removed from the tubes by means of a steam pipe with a perforated head inserted at various openings in the settings twice a week. One rule rigidly enforced is that no responsible man is allowed to leave the plant until the man who is to relieve him has gone over the plant and has noted the condition of the apparatus.

In order that the efficiency may be kept up to the highest point possible with the equipment installed, complete tests are run occasionally on the several boilers under operating conditions, but it is unfortunate that instruments, scales, thermometers, etc., are not installed as a constant aid to the firemen. We give below the results of one test which is reported to be made under operating condition and shows what good results can be obtained; nobody knows, however, that these results are maintained day after day; they probably are not, as any fireman will do better work when he knows a record will be kept of his work and he has the testing instruments to guide him.

Result desired	Capacity
Kind of fuel	Fairmont, W. Va., Slack
Kind of Furnace	Murphy Dutch Oven
Kind of stoker	Murphy
Kind of Superheater	None
Kind of Economizer	None
Duration of trial	8 hr.
Grate surface	42 sq. ft.
Water heating surface	3,089 sq. ft.
Superheating surface	104 sq. ft.
Ratio water to grate surface	73.5
Steam pressure, gage	129.5
Draft between boiler and damper	0.69 in.
Draft in furnace	.47
Average temperature feed water entering boiler	60 deg.
Average temperature escaping gases from boiler	596 deg.
Equivalent weight coal as fired	14,123 lb.
Percentage moisture in coal as fired	4.5
Total weight dry coal as fired	13,487 lb.
Total ash and refuse dry	1055 lb.
Total combustion consumed	12,432 lb.
Percentage ash and refuse in dry coal	7.82
Dry coal fired per hr.	1686 lb.
Combustible consumed per hr	1554 lb.
Dry coal per sq. ft. grate surface per hr	40.2 lb.
Combustible per sq. ft. heating surface per hr	0.503 lb.
Percentage volatile	35.1
Percentage fixed carbon	55.5
Percentage ash	9.4
Percentage sulphur	.4
Calorific value per lb. dry coal	13,683 B.t.u.
Calorific value per lb. combustible	15,090 B.t.u.
Percentage carbon in ash and refuse	13.6
Percentage earthy matter in ash and refuse	86.4
Quality of steam	Assumed 100
Total weight water fed to boiler	116,124 lb.
Water actually evaporated corrected for quality	116,124 lb.
Factor of evaporation	1.198
Equivalent evaporation into dry steam from and at 212	139,117 lb.
Water evaporated per hr. corrected for quality	14,516 lb.
Equivalent evaporation per hr. from and at 212 deg.	17,389
Equivalent evaporation from and at 212 deg. per sq. ft. heating surface per hr	5.63
Boiler hp. developed	504
Builders' rating, hp	300
Percentage rating developed	168
Water apparently evaporated per lb. coal as fired	8.22
Equivalent evaporation from and at 212 deg. per lb. coal as fired	9.86
Equivalent evaporation from and at 212 deg. per lb. dry coal	10.32
Equivalent evaporation from and at 212 deg. per lb. combustible	11.18
Efficiency of boiler	71.9
Efficiency of grate	73.2
Cost of 2000 lb. coal, delivered	$2.65
Percentage CO_2	14.20
Percentage CO	.07
Percentage O	4.80
Percentage N (by Dif.)	80.93

The Goodyear Power Plant

IN THE ISSUE of April 3 of the "Wingfoot Clan," which is a factory publication of the Goodyear Tire & Rubber Co., the power plant of the factory at Killingly, Conn., where the fabric for tires is manufactured, was briefly described. This plant consists of 2 125-hp., and 2 100-hp. return tubular boilers, Perfection shaking grates, turbo-blowers, Vulcan soot cleaners, and Spencer damper regulators, served by a brick stack 44 in. inside diameter and 75 feet high. The boilers are hand fired with bituminous coal, supplied with feed water by 2 boiler feed pumps, one a Burnham, 8½ by 5½ by 10 in., and one Dean 7½ by 5 by 10 in. Feed water is heated by a 500-hp. open Cochrane heater, which takes the returns from traps and heating system, these returns being taken care of by a Burnham 8 by 10 by 12-in. vacuum pump, which delivers to the heater.

In the engine room is a crab claw single eccentric Corliss engine, 23¼ by 60 in., running at 70 r.p.m., exhausting into a Dean jet condenser, which is served by a 10 by 14 by 18-in. vacuum pump, the exhaust from this pump and from the boiler feed pumps going to the feed water heater, and together with returns from the heating system, raising the temperature of the feed water to 180 deg. under light load conditions.

In addition, there is a water power plant, consisting of 2 54-in., and 1 48-in. Holyoke vertical water wheels driving a jack shaft to which the engine is also belted, the arrangement permitting of driving by either the water wheels or engine, or by both together. When the wheels are running alone, the speed is governed by a Holyoke oil pressure governor, and when engine and wheels are running together, the speed is regulated by the engine governor. The mill is driven from the jack shaft by a main belt driving the line shafting on the first, second and third floors.

In a separate mill is a 48-in. water wheel, belted to a 100-kv.a., 3-phase, 60-cycle Westinghouse a.c. generator, delivering current at 600 v. for lighting of the mill, the auxiliary buildings, and the principal streets of the village. Also, this outfit supplies power for 3 10-hp. and 5 5-hp. induction motors in the picker room.

There is, also, one other 48-in. Holyoke wheel connected by a belt to a line of shafting on the second floor, and also connected to drive the machine shop and a No. 4 Fales & Jenks rotary fire pump.

This fire pump drive, as also that of a second rotary fire pump in the wheel house with the larger wheels, is by means of grooved friction gears on the water wheel shafts, each pump being able to deliver 969 gal. per min. The 5 wheels run at 77 r.p.m., under a 10-ft. head, and develop together 750 hp., discharging 20,950,000 gal. of water an hour. To supply the water for them, a dam 250 ft. long extends across the Quinebaug River, about 1000 ft. from the mill. This dam is of heavy timber construction, and, at the east end, has 9 gates to control the flow of water to the canal, which conveys this water to the wheels.

As a further protection against fire, there is in the engine room a Dean duplex steam fire pump, 18½ by 10¼ by 12 in., with capacity of 1000 gal. a min.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Control and Protection for 100,000 Volts

HIGH VOLTAGE TRANSFORMING AND SWITCHING, AND OVERLOAD DEVICES FOR 24,000 AMP. D. C.

INSTALLATION of 9 2500-kw. 60-cycle rotary converters at the Little Tennessee Plant of the Aluminum Company of America at Maryville, Tennessee, in addition to constituting one of the largest 60-cycle rotary converter installations in the world, presents a number of interesting features in the arrangement of the controlling and protective equipment.

Energy is brought to the station by the Tennessee Power Co. over a single-circuit transmission line 70 mi. in length, consisting of 400,000 circular mil stranded aluminum cables, carried on steel towers 55 ft. in height, the lines being hung from suspension insulators.

Temporarily a transmission voltage of 60,000 is used, which later will be boosted to use 110,000 volts.

OUTDOOR APPARATUS

TWO BANKS of 3 3650-kv.a. 110,000 to 66,000-volt outdoor single-phase transformers are used to step down to rotary voltage, operating 4 6-phase rotaries from independent secondaries on each bank, with provision for operating one spare rotary from any set of secondaries of either bank.

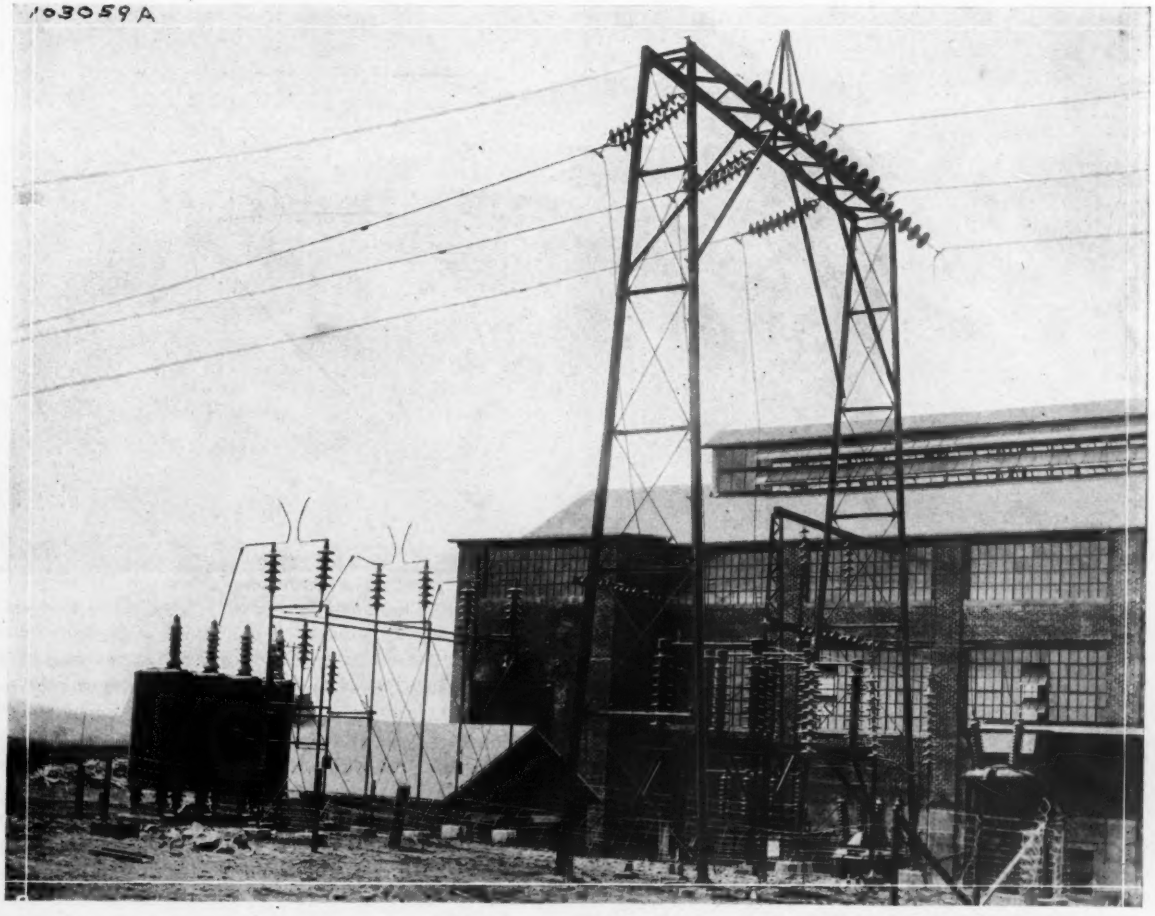


FIG. 1. OUTDOOR HIGH VOLTAGE EQUIPMENT; TRANSFORMERS, OIL CIRCUIT BREAKERS, AND DISCONNECT SWITCH

Automatic overload protection is provided by 3-pole outdoor oil circuit-breakers equipped with outdoor condenser-type terminals and ring-type current transformers. The breakers are solenoid operated, and are controlled from the control desk located in the station.

The breakers are isolated from the transmission line by means of 3-pole outdoor disconnecting switches which are mechanically controlled by means of a handle installed in the station, one of these switches being shown in Fig. 1 between the supports of the transmission tower. The outdoor lightning arrester of the electrolytic type shown at the left provides protection against lightning.

be used. Due to the size of the rotaries, and their large overload capacity, the switching equipment for both the a.c. and d.c. ends of the machines is necessarily unusual in character.

For the control of the a.c. ends of the converters, 2500-amp., 3-pole solenoid-operated automatic carbon circuit-breakers are used, and for the d.c. ends, the control consists of 2 5000-amp. single-pole solenoid-operated automatic carbon circuit-breakers for each machine.

The a.c. and d.c. panels are located adjacent to each machine, thus reducing to a minimum the length of main connections. Low voltage protection is provided

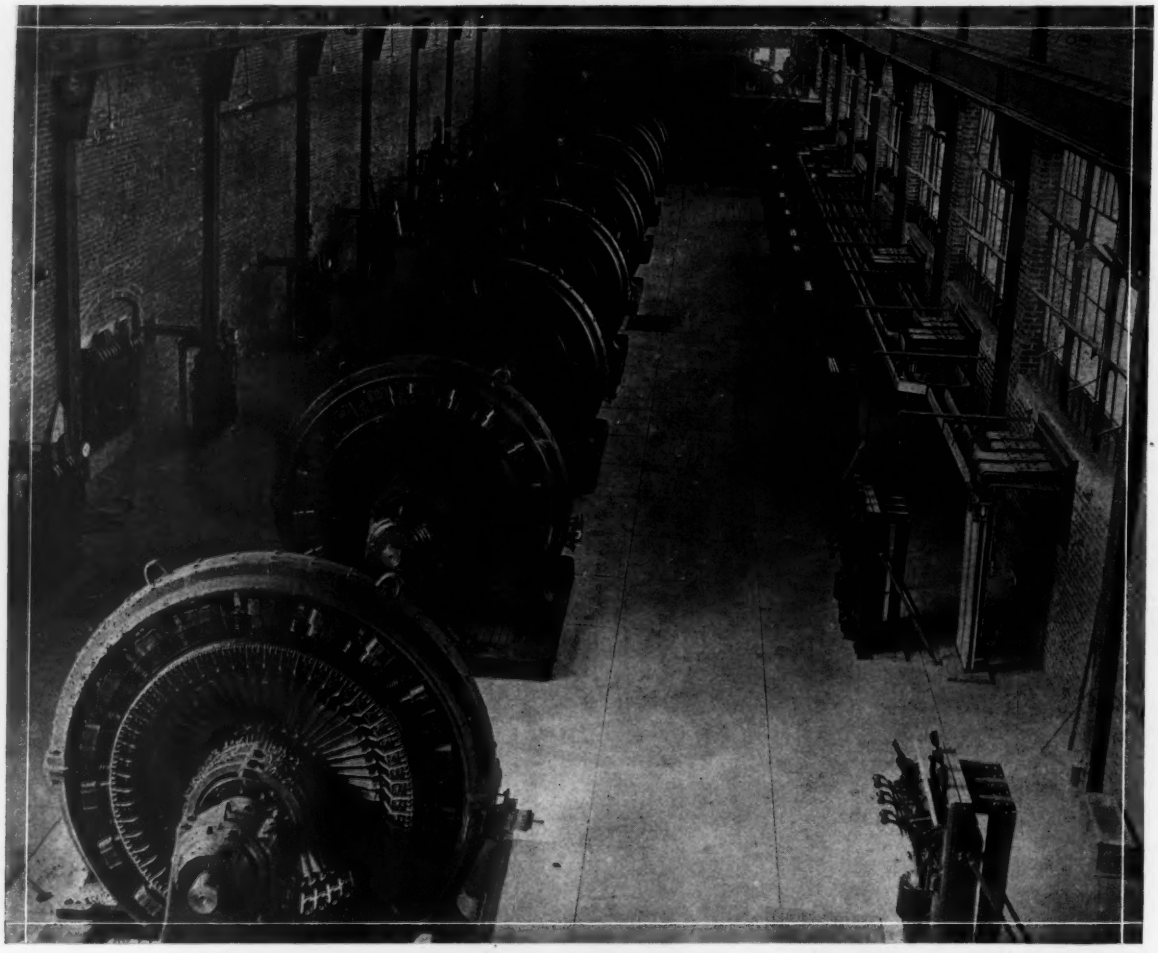


FIG. 2. INTERIOR OF SUBSTATION; ROTARIES, A. C. AND D. C. PANEL BOARDS

Rotary Control

Low-tension leads from the transformers are carried directly through the station wall and the 6-phase connections are made by means of aluminum conductors located beneath the floor. The aluminum strap bus arrangement shown along the right-hand station wall in Fig. 2 provides the necessary connections for transferring the spare rotary converter to any set of secondaries of either bank of step-down transformers.

The 9 rotary converters are 2500-kw., 6-phase, 60-cycle, 400 r.p.m., started from 500-volt d.c. side, but 2 of the units are arranged so that an a.c. starting motor may

on the a.c. panels, and protection against reversal of d.c. current is secured by means of reverse-current relays on the d.c. panels.

The output of the rotaries, which is used in the manufacture of aluminum, is distributed through a 20,000-amp. single-pole solenoid-operated automatic carbon circuit-breaker, and 2 10,000-amp. single-pole solenoid-operated automatic carbon circuit-breakers which are mounted directly against the left-hand station wall shown in Fig. 2. The panels for the control of the d.c. ends of the rotaries are shown on the left-hand side of the station.

The ratings given for the carbon circuit-breakers are for full load based on 70 deg. F. temperature rise, but based on the National Electrical Code rise of 86 deg. F., the breaker ratings are considerably higher. The 20,000-amp. breakers mentioned are in fact good for 24,000 amp.

Heavy Circuit Breaking

Details of the brush construction of the 24,000-amp. breaker are shown in Fig. 3. The main brush consists of 6 unit brushes of laminated copper so spaced as to secure the benefit of maximum ventilating effect. Auxiliary arc-interrupting contacts are located above the main brush and on the lower portion of the carbon contacts, which make the final break. Laminated studs are used

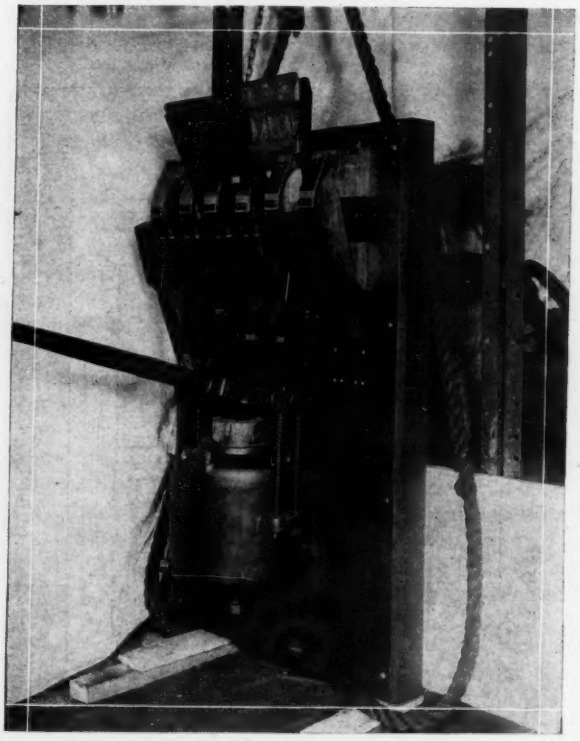


FIG. 3. 24,000-AMPERE CIRCUIT BREAKER

for all breakers, and a single solenoid is used for operating each breaker, regardless of the number of poles, making possible a very simple and direct-acting operating mechanism.

Metering and controlling equipment for the a.c. and d.c. sides of the rotary converters, as well as for the high tension side of the step-down transformers is installed upon the control desk located in the balcony in the corner of the station, Fig. 2.

The installation is a demonstration of the convenience of electrical control for the switching equipment, permitting the concentration of the control at a convenient point, and making possible the location of switching equipment advantageously from an installation and operating standpoint.

Current for operating the solenoids of the switching equipment and for the station lighting is provided by means of a motor generator set consisting of a 60-kv.a., 125-250-volt, 3-phase generator driven by a 500-volt d.c. motor.

The metering equipment of the power company consists of one watthour meter for each group of 4 rotaries, the meters being operated from totalizing current transformers which are fed from the secondaries of current transformers located on the leads of each rotary circuit. Each watthour meter thus registers the total input to 4 machines.

The complete electrical equipment for this station was manufactured by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., under the direction of William Hoopes, Electrical Engineer of the Aluminum Co. of America.

Exciters and Excitation*

Exciter Capacity. By Gordon Fox

EXCITER capacity in a plant may be variously obtained. In most isolated plants, one exciter is provided for each alternator and these are either direct-connected or belted to the main units. This practice is subject to some objections. A heavy load on the prime mover will slow down not only the alternator but its exciter as well, hence the voltage drop under this load will be more severe than if the exciter rotation were maintained independently. Units of this kind are interdependent so that the arrangement is not flexible and exciter trouble may cause the shut-down of the alternator also. In the larger plants, separate exciter units which are motor-driven or connected to their own prime movers are more common. At least one independently driven exciter is required in case the alternating voltage should be lost and the motor-driven exciters thus rendered useless. There should be at least 2 and preferably 3 or more exciter units in a plant. With too few large units, the capacity may be too greatly reduced by shut-down of one unit. The exciter capacity is usually made such that its rated load is equivalent to the normal full load excitation for the entire plant. The exciter overload capacity will then handle the peaks over and above the full station capacity. Exciters for individual machines should be capable of handling 10 per cent more than specified maximum load upon their respective alternators for the same period corresponding to the overload guarantee of the alternators.

Motor-driven exciter units are probably the most economical type since they are ordinarily of larger size than individual exciters and of correspondingly better efficiencies. Induction motors are more commonly used for this service on account of their simplicity and reliability. Synchronous motors have the advantage of more constant speed and may be used for power factor correction, but require more careful attendance and may fall out of step or hunt, with attending serious results. When exciters are belt driven from the main units the pulley sizes should be liberal to prevent slippage under the heavier loads when their good performance is most important. There is a tendency when purchasing belted exciters to use machines of high speeds, since they are somewhat cheaper; but this practice is not commendable on the basis of reliability, since high-speed, direct-current machines are more subject to commutator and commutation troubles than are those of more moderate rotation.

*Continued from page 536, June 1 issue.

The writer would not recommend the use of exciter speeds exceeding 1500 r.p.m., and 1200 r.p.m., or lower, is probably a more advisable rate.

If both alternator and exciter be of the belted type, the alternator is commonly provided with a large driven pulley on one end and a small pulley for driving the exciter upon the other shaft extension. The main belt is adjusted by moving the alternator on a sliding base, and the exciter must then be moved correspondingly. In many plants, the exciter is mounted upon an independent sliding base and there is no other connection to the alternator, rendering it difficult to adjust the main belt without first making the exciter belt quite loose or tightening it up dangerously while moving the alternator, and then easing off. This difficulty may be overcome by providing a spacing rod between the alternator and the sliding base of the exciter, as shown in Fig. 4. The exciter base is then mounted upon a pair of rails so that it may slide along them and yet retain its alinement.

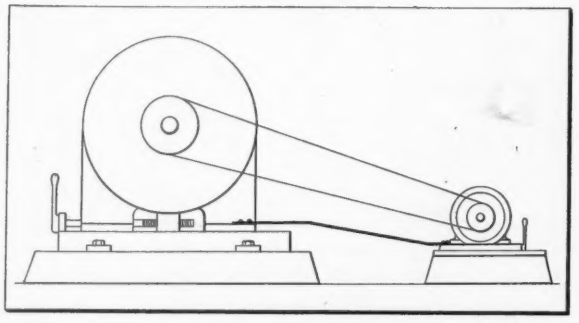


FIG. 4. SPACING ROD BETWEEN ALTERNATOR AND SLIDING BASE OF EXCITER

Another method of accomplishing the same result utilizes an adjustable spacing rod provided with a turnbuckle. This then reaches from the alternator to the exciter, the latter sliding upon the standard base or rails provided with it. Another arrangement, quite common but well liked where used, is that of making use of a special end bracket upon the pulley end of the exciter. This bracket is provided with an idler pulley and a spring for taking up slack in the belt. With this arrangement a more compact location of exciters and alternators is possible, and it is an easy matter to care for their relative movements when tightening belts.

The arrangement of electrical connections between exciters and alternator fields is quite flexible and differs in different installations. In some plants, particularly those of the smallest class, the exciter terminals are simply brought out to a double-pole, single-throw switch leading to the alternator field through a rheostat. This arrangement is possible only when there is an individual exciter for each alternator. A point of weakness exists when 2 or more units are paralleled. Since the excitation of each unit is independent, relative variations are likely to occur so that cross currents may be prevalent as a result. In the larger plants there are nearly always one or more pairs of exciter bus bars, with the exciters connected in parallel to them and which supply current to all of the alternator fields. This arrangement is flexible and fits in readily where there are 2 or more exciters feeding a number of alternators. The arrangement lends itself readily to control by means of a Tirrill regulator.

Switchboards in the smaller plants do not usually include an exciter panel. The exciter switches, meters and rheostats are often mounted directly upon the alternator panels, this layout being common where each unit includes its exciter. But where exciter busses are used, it is more common to provide an exciter panel upon which are mounted the exciter switches, meters and rheostats. If a Tirrill regulator is used, it is then also mounted upon the exciter panel. In plants equipped with Tirrill regulators but without exciter panels, it is most common to mount the regulator upon a bracket adjacent to the outside generator panel. A good typical arrangement for an exciter panel is shown in Fig. 5, a connection diagram.

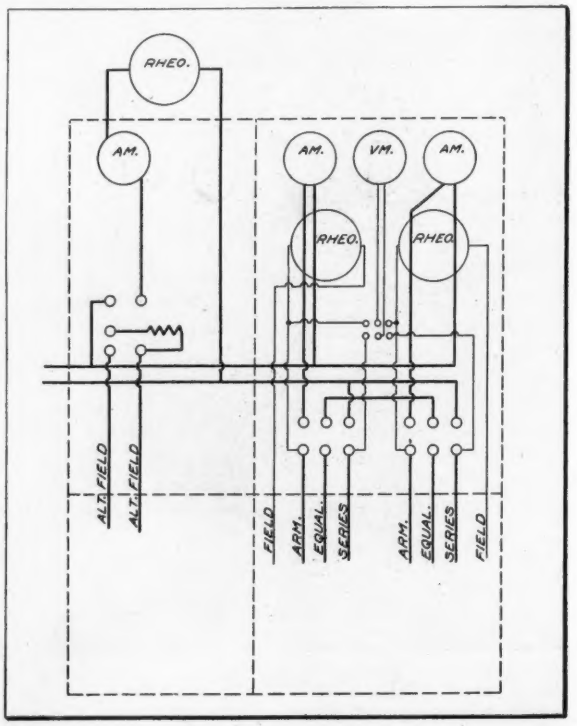


FIG. 5. CONNECTION DIAGRAM OF AN EXCITER PANEL

It will be noticed on station switchboards that the field switches for practically all alternators are provided with an extra clip which is arranged to short-circuit the alternator field across a resistance the instant that the field is disconnected from the exciters. This resistance is called a "discharge" resistance and its function is to absorb the inductive kick from the alternator fields at the instant the flow of current in them is discontinued. The alternator or field windings are interlinked with a strong magnetic circuit, and when the exciting current is suddenly killed and falls to zero, the change in magnetic condition induces a high instantaneous voltage in the field coils caused by self induction. If a discharge resistance were not provided, the field winding insulation might be punctured.

It is possible to vary the voltage of an alternator or alternators by changing the exciter voltage through use

of the exciter rheostats or by means of the alternator rheostats themselves. When individual machines are being controlled, it is usually preferable to leave the alternator field rheostat fully cut out and to do the adjusting by changing the exciter voltage. The resistance losses in the exciter rheostat are lower than those of the alternator rheostat. Also, it is well to run the exciter on low voltage and moderate load as far as possible for the sake of reliability and minimum wear. The losses in the alternator field rheostat are wasted and form a useless burden upon the exciters. When 2 units are paralleled and the exciters are also parallel operated, it is more common to run the exciters at about 110 v. and to vary the alternating voltage by using the alternator rheostat. There is no reason why this should be done other than that the exciters are perhaps a little more stable under the stiffer field. Where a Tirrill regulator is used in connection with parallel units, the alternator rheostats are mostly or entirely cut out and the line voltage is maintained by automatic variation of the exciter voltage. The alternator rheostats are then used only to minimize cross currents.

The relation of excitation to load division between alternators in parallel is a matter of importance not always clear. With direct-current machines it is possible to apportion the load between individual units by variation of excitation and manipulation of rheostats. With alternators this is not the case. Direct-current generators maintain equal voltages in parallel through the action of equalizing current through the series fields. A similar action occurs with alternators but in a different manner. Two alternators in parallel will have equal terminal voltages, no matter how they may differ in excitation. That machine which is overexcited will generate a current which will flow through the other alternators armature windings. This cross current will supplement the excitation and make up for that lacking in the field windings. It is thus seen that to change the excitation of one alternator in parallel with another will merely set up or change the cross currents flowing between them and will not affect the actual delivered electrical load. The actual load division depends entirely upon the regulation characteristics of the prime movers.

Induction Motor Repairs

By R. G. Curren, Jr.

A SMALL squirrel-cage induction motor of ½ hp., used for pumping oil to overhead tanks, became so hot as to melt the solder between the short circuit rings on the rotor.

This was caused by the current being taken off the line and the switch not opened, which resulted in the windings becoming hot when the current was put back on the line again. The switch, not being on the starting point of the resistance, would not start the motor, but allowed the current to pass through, heating it up so that the solder ran out of the short-circuit rings before the damage was discovered. After letting it cool down, we tried to start it, but could not. Then when the engineer saw what the trouble was, he set about repairing the damage.

A solder pot and small ladle were secured. While the solder was melting, the rings and ends of the bars were cleaned and made ready to solder. As the rotor would not go into the pot, it was held above and the solder poured on with the ladle, which, of course, made a rough job. This, however, was afterward smoothed up in a lathe.

This same thing had happened before on other small motors, which were always sent back to the factory for repairs.

I remember at one time the engineer on the shift had similar trouble, but did not know what was wrong. Upon taking out the rotor, he saw that it was rubbing on the stator windings and without further examination he started to file off that part of the rotor which had been rubbing. While this helped matters a little when starting, the motor continued to lie down under load, so it was finally also sent to the factory.

Relation Between Size and Horsepower of D. C. Motors

SOME misunderstanding is prevalent regarding the relation between the size of a motor and its power output. The size of a motor is determined not by its horsepower but by its torque. The size is determined in general in such a way that it will radiate the heat generated in its windings without undue rise of temperature. If the temperature of a machine is constant, the amount of heat energy generated in the machine is equal to the heat energy radiated or otherwise removed from the machine, as by artificial ventilation. The amount of heat dissipated is proportional to the radiating surface times the difference in temperature between the machine and the surrounding air. Since the radiating surface of a given machine is constant, the temperature rise above the surrounding air is proportional to the amount of heat energy radiated, and the temperature will rise until the generation and dissipation of heat are equal. The heat generated in the windings is proportional to the square of the current so that the current a machine will carry without overheating is limited. The torque developed by a motor is proportional to the current times the flux. The flux density which can be used is fixed quite definitely so that with a given size of machine, using the best materials, the flux is practically determined. This makes the torque depend on the current and consequently on the size of the machine. The power output is proportional to the torque times the speed, so the size of a machine for a given power output depends on its speed. —The Electric Journal.

The Bureau of Mines is conducting a series of investigations with the common aim of minimizing the losses that occur in the mining and treatment of mineral substances. One report of the Bureau treats of a method of preventing some of the waste of the natural gas incidental to oil mining. This method, the condensation of gasoline from natural gas, offers to the oil operator and others a profitable means of utilizing some of the oil-well gas now being wasted. The most desired constituent of crude oil is obtained, the production of oil is not hindered, and the gas loses but little of its heat value.

Foreign Development in the Power Plant Field

THE STABY SMOKE CONSUMER; THE HATFIELD ELECTROLYTIC AMMETER. BY J. H. BLAKEY

PREVENTION of smoke in a boiler furnace is dependent, as probably every engineer will agree, upon the admission of a sufficient amount of air over the fuel at the proper time. This is accomplished in an ingenious way by the Staby smoke consumer, which is described in Le Genie Civil. Referring to Fig. 1, A is an air injector, B a steam distributor and R a steam reservoir. The method of operation is as follows: When the furnace door is opened the reservoir R is put into connection with the boiler, which supplies steam to the distributor, B, through the supply pipe, SP, the opening of the furnace door moving a valve in the interior of B by means of the valve rod, F. The result of this is that the amount of steam stored in the reservoir, R, is proportional to the length of time the door remains open,

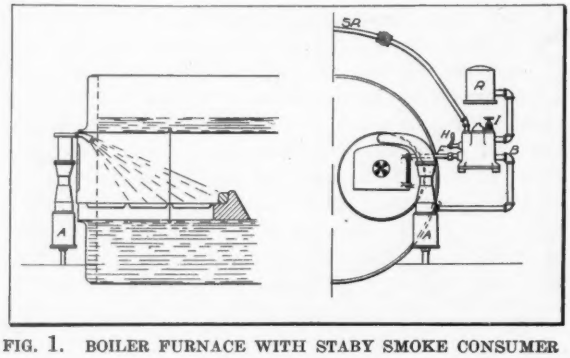


FIG. 1. BOILER FURNACE WITH STABY SMOKE CONSUMER ATTACHED

and consequently to the amount of coal which is thrown on the fire. The closing of the door cuts off this connection and opens the pipes from R to the air injector, A.

Thus there is blown into the furnace a quantity of air sufficient to supply the oxygen required for the complete coking of the mass of fresh coal. Without further regulation, however, it might happen that an excess of air would be supplied at the beginning of combustion, and that the supply would be exhausted before its completion. In order to avoid this, the regulator, B, has a needle valve, I, which can be manipulated by the fireman in such a way as to throttle the steam supply and so shorten or lengthen the period of the flow of steam, according to conditions. If a situation arises in which an insufficient amount of steam has been collected in the reservoir, R, a direct connection can be made between boiler and air injector by operating the handle, H.

HATFIELD ELECTROLYTIC AMMETER

THE HATFIELD electrolytic ammeter is based upon the principle of the Grove gas battery, in which the cell consists of 2 glass tubes partly filled with water, and the remainder with oxygen and hydrogen respectively. The ammeter, as shown by Fig. 2, consists of a closed U tube, GD, containing an electrolyte, the space not occupied by the liquid being filled with hydrogen. The electrodes A and C are arranged as shown; the cell is connected in parallel to a low resistance shunt, S, and in series with a high resistance, R. The drop of potential on S is about one volt, and the resistance R is from 10,000 to 20,000 ohms.

In order to avoid the polarization of the electrodes, and the consequent inaccuracy of the readings, a special arrangement has been devised for the cathode, C. This is a sort of thimble, shown in detail, open to the electrolyte only by a grating of very fine gold wire coated with rhodium black. The holes in the grating average 1/10 of a millimeter in diameter, and as the wire is in contact

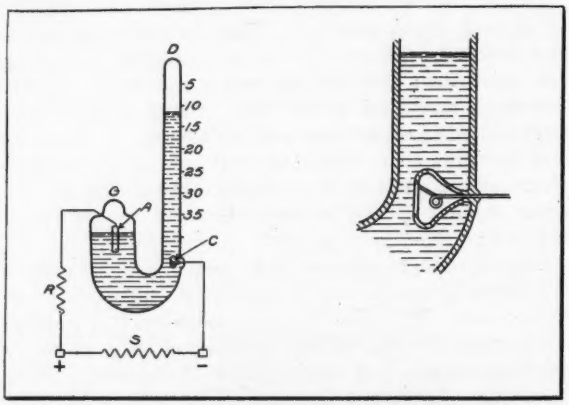


FIG. 2. HATFIELD ELECTROLYTIC AMMETER

with the grating, this acts as cathode. The anode is of platinum, and is coated with platinum black. The electrolyte used is phosphoric acid. When the hydrogen fills the graduated part of the tube the instrument is inverted, which causes the return of the liquid to the graduated leg.

U. S. CIVIL SERVICE COMMISSION announces an examination for electrical engineer and draftsman, on June 23 and 24, 1915, to fill vacancies as they may occur in this position at $1200 a year, in the office of the Supervising Architect, Treasury Department, Washington, D. C., and in positions requiring similar qualifications. The following subjects will have the relative weights indicated: Theoretical and practical questions in electrical science (covering the subject with special reference to lighting and elevator work in public buildings), 25; drawing and design (involving ability to design and draw plans, etc., for all apparatus and machinery connected with electrical work in public buildings), 40; training and experience, 35. Applicants must have the equivalent of a high-school education and not less than 3 yr. special experience as a draftsman principally in connection with electrical work and illuminating engineering, or be technical graduates with not less than 6 mo. experience as electrical draftsman or practical experience in the installation of electrical wiring or apparatus. Age, 22 yr. or over on the date of examination. Applicants must submit to the examiner on the day of the examination their photographs, taken within 2 yr. Apply for Form 1312, stating the title, Electrical Engineer and Draftsman (Male), to the U. S. Civil Service Commission, Washington, D. C.

Trapping to the Boiler

By Arthur A. Rice

IN order to appreciate the value of the Morehead Back-to-Boiler System, it is first necessary to install one, then its value is quickly noted for boiler feeding purposes. At the Hoyt Bldg., Wholesale Grocery House, Chicago, Ill., the Morehead System was installed by the writer, to return the condensation from the various heaters and kettles, as well as the heating system back to the boiler.

This system is installed to allow for a gravity discharge from all 3 traps. A 2-in. vacuum trap, which will pull 22 in. of vacuum, is used to drain the heating system, and is installed about 4 ft. above the receiver. The cooking kettles, which are located on the fifth floor, are supplied with steam at about 20 lb. pressure, this condensation being returned to the receiver by a small return trap, located on the fourth floor. Water from all boiler pressure kettles and heaters is returned direct to the receiver, also from the main header, which has a ¾-in. pipe line direct. This practically puts boiler pressure on the receiver at all times. All make-up water is added through the vacuum trap.

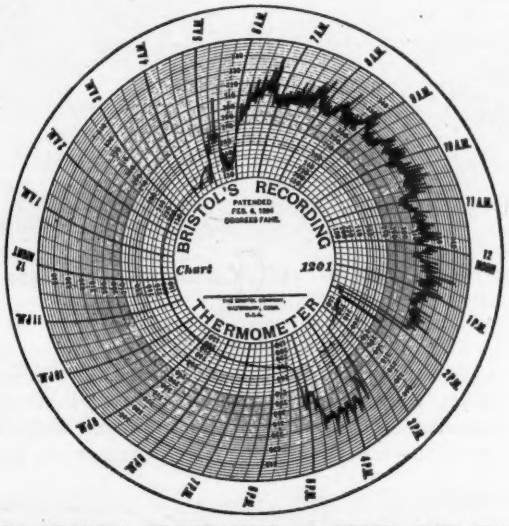


CHART SHOWING TEMPERATURE OF BOILER FEED WATER WITH TRAP SYSTEM AND WITH PUMPS

Water passes from the receiver to the trap on top of the boilers, which is installed about 4 ft. above the water line. Nearly all the scale from the make-up water is deposited in the receiver, where it can be blown out before it gets to the boiler.

These traps need practically no attention,—the trunnions once packed will last for 6 months or better with a little tightening once in awhile. No oil gets into the boilers, and the water level in the boilers is always where it should be. The faster steam is generated, the more condensation there is to return, so after the amount of make-up is once learned, water can be added gradually, without changing more than 2 or 3 times a day, and the water level in the boiler will not vary more than ½ gage.

Since these traps were installed, they have shown a saving of about 10 per cent in coal over previous records when using pumps. At that time all condensation returned by pump and continuous flow traps to an open tank, whence it was taken for boiler feeding. The boiler feed water then had a temperature of about 180 deg. F., where with the Morehead System it averages 280 deg. or better.

The following table shows the evaporation for a week's run of 5½ days, starting with a cold boiler every morning.

	Lb. coal burned	Lb. water evaporated.	Evaporation
Feb. 8	11,600	122,360	10.55
Feb. 9	7,300	74,200	10.19
Feb. 10	6,500	66,220	10.18
Feb. 11	5,000	49,000	9.80
Feb. 12	5,000	46,620	9,32
Feb. 13	3,200	30,680	9.27
Total	38,600	389,080	Average 10.08

This record I consider good for a Scotch Marine boiler with a Burke furnace, steam carried at from 100 to 125 lb. gage pressure, with No. 2 Carterville washed nut coal.

The accompanying chart taken, Feb. 12, shows the difference in results between the traps and the pumping system. The pumps were started at 2 o'clock and run until 3:30. At 2:15 the traps were opened to drain a tank of its condensation, then they were again stopped.

Heat of Ice and Water at Low Temperatures

THE substance of this article is taken from the report of the U. S. Bureau of Standards, by H. C. Dickinson and N. S. Osborn, and embodies the results of experiments carried out by the Bureau, and information presented by A. W. Smith in "Physical Review" for 1903.

The former experiments have indicated, apparently, a change in the specific heat of ice; but Mr. Smith found that this was largely due to impurities in the ice, which lowered the melting point, that if the ice be kept practically pure, the specific heat is constant up to temperatures very close to zero. The original article gives some description of the calorimeter used, and of the method of carrying on the experiments, and that the specific heat as averaged from the determination upon 4 samples, as pure as could be obtained, has but a slight departure from a constant value, depending on the temperature, and for practical purposes, may be taken as 0.5057, the specific heat of water being taken as 1. Experiments on the heat of fusion of ice gave an average of 143.55 B.t.u. per lb.

A table of total heats of ice and water from —20 deg. F. to +100 deg. F. is given in the Practical Reference Tables, the values being based on this determination.

Correction Note

Our attention has been called to a typographical error which appears on page 553 of the June 1 issue. In the sixth line from the bottom of the first column, it is stated that "ten thousand divided by 5000 = 20 amp." This should be "one hundred thousand divided by 5000 = 20 amp."

Water Power in Public Lands

GENERAL DETAILS CONCERNING THE POWER POSSIBILITIES OF WATER FLOWING THROUGH THE PUBLIC LANDS. BY A. P. CONNOR

IT is hard to appreciate what the power bills introduced into the last Congress and recommended by the President, mean from the general facts and figures presented. The writer has therefore obtained some facts concerning them, together with illustrations that may make the matter of more practical value, especially as actual instances are given for the consideration of the readers.

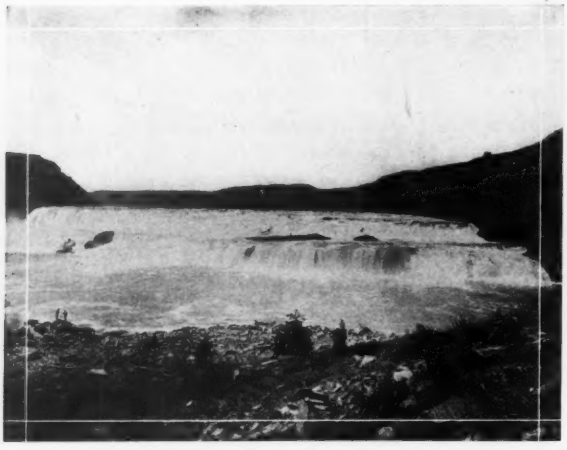


FIG. 1. RAINBOW FALLS ON THE MISSOURI RIVER NEAR GREAT FALLS, MONTANA

It may be mentioned that the water power in the Public Lands, while not the only valuable source of water power, controlled by the Federal Government, is still usually the easiest to develop and is usually in a location particularly valuable for some special community or industry. The amount of power that is of practical value and available in the Public Lands runs into the millions of horsepower. In fact, it is greater than is now developed at the present day in the public plants of the United States. All this power is practically going to waste at the present time, due to the fact that there is no adequate legislation to permit it to be used in a desirable manner.

In Fig. 1 is shown the Great Falls on the Missouri River in the State of Montana in the vicinity of Great Falls. It appears that at this point not even a dam is necessary to obtain 20,000 hp. at the lowest water. The drop is 75 ft. in this vicinity. With a little expense, comparatively, and the construction of a dam, 50,000 hp. could readily be obtained, and under an extensive scale much greater amount of power could be obtained. There is plenty of space for impounding the waters behind a dam here. If 50,000 hp. were developed at a plant situated in the location, and each horsepower sold for $100 a year, which is low enough, the income would amount to $5,000,000 annually and the source of power would be continual.

FIG. 2. BENHAM FALLS ON DESCHUTES RIVER

In the vicinity of Great Falls there are plenty of opportunities to use the electricity developed, such as smelters, railroads, as well as industries which are desirable to every large community.

DESCHUTES RIVER, OREGON

IN FIG. 2 is shown one of several locations that could be readily utilized on the Deschutes River in Oregon. On this river are Dillon Falls, Lava Island Falls and Benham Falls, a portion of the latter being shown in the illustration, and all within a short distance of each other. They have a combined drop of 300 ft., with favorable sites for the construction of plants for water power development. It is even possible to get power at a small outlay by using a low diversion dam and running the

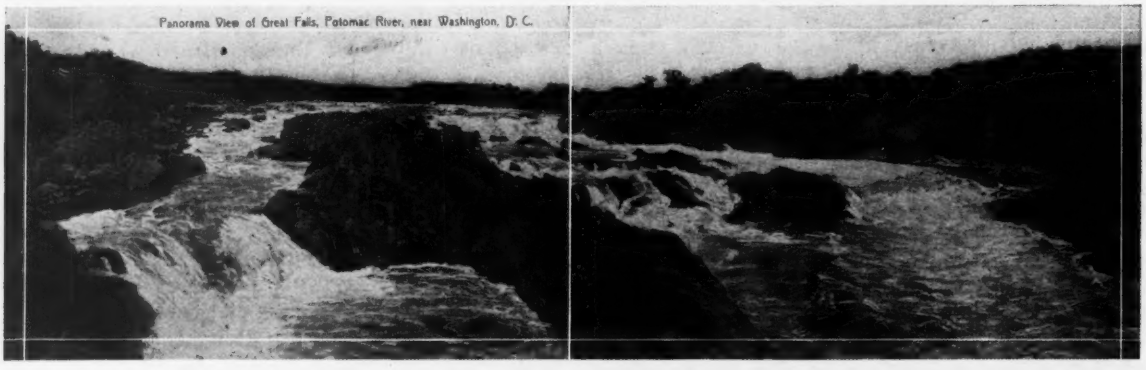


FIG. 4. GREAT FALLS ON THE POTOMAC RIVER

water through conduits to lower levels. About 800,000 hp. could be developed here, and there are plenty of uses for the power, even to the development of irrigation projects of immense value in this locality.

Pend Oreille River, Washington

The Pend Oreille River in the State of Washington is shown in Fig. 3, and words appear hardly necessary to mention the location shown as being desirable for a dam. The canyon through which the river flows at this point is 250 ft. high or more and the flow is about 6000 cu. ft. a second. It is situated fairly close to the city of Spokane, being only 80 miles away, and at this point, which is known as Clarke's Fork, there are plenty of prospects for the development of water power to the amount of 100,000 hp. and over. Nitrate fertilizers could readily be manufactured here owing to the immense quantities of lime rock present. There is plenty of timber land that has been untouched and quantities of land that could be opened if properly irrigated.

FIG. 3. CANON OF PEND OREILLE RIVER

In the same State of Washington there are capabilities for water power development on the Columbia River at Priest Falls, the estimated minimum being calculated to be 400,000 hp. and the maximum 1,500,000 hp. There are a number of other opportunities in the same state.

Washington, D. C.

It is not generally known outside of the city of Washington that there are great possibilities for the development of power to supply the city and government needs. The location is on the Potomac River at Great Falls, just outside of Washington. The investigation of the U. S. Engineers for Congress recommended a location for the power development in the city of Washington and the preliminary plans have been made up and ready for use at any time. The water for the city is derived from the same river and the erection of another dam and power station at the point selected would add to the water supply as well as provide a lake and fish supply for the city. For reasons unpublished, this project always seems to be side-tracked and the Government makes contracts for power to the local company which are not above criticism in the matter of contract price and arrangements.

Under suitable legislation to protect the interests of the public, many of these power developments in the public properties of the country could be opened so they could be utilized by private or municipal parties.

My Efficiency

In an organization, as in a chain, the weakest link determines the strength. And the effectiveness or efficiency of the organization depends on the effectiveness of the individuals as well as their fitness to work together. Each one, to be effective, must be personally efficient, and as it is well to test the efficiency of a machine, so is it good to test our own efficiency to determine whether we can improve and where; to take account of stock, and find along what lines should be our effort to expand.

Following are a few leading points for self analysis, suggested by Edward Earle Purinton in The Independent. An honest "Yes" would mean 100; an honest "No" 0; a partial credit can be made according to the self judgment of the individual. The sum total of the credits divided by 25 will give your average estimated efficiency.

If you're not satisfied with the average, the credits will indicate where thought and effort can be applied to raise it.

Per Cent

1. Is your work agreeable?.....
2. Are you doing it in the best, and quickest way?
3. Have you found where your greatest power lies?
4. Have you a definite aim in the line of this power?.....
5. Are you positive of your own future success?..
6. Can you look on the bright side, always?.....
7. Do you know how to get well and keep so?....
8. Do you know what habits and emotions hurt your work?.....
9. Are you correcting your weaknesses?.....
10. Have you taken stock of your strong and weak points of mind and character?.....
11. Do you know what food, exercise and baths are most beneficial?.....
12. Are deep breathing and an erect body habitual?
13. Is your sleep long and refreshing and room well ventilated?.....
14. Are your meals regular and eaten slowly?....
15. Do you wear loose, comfortable clothing?.....
16. Are you positive and courageous?.....
17. Are you tactful and courteous?.....
18. Do you get the co-operation of fellow workers?
19. Do you plan your day ahead?.....
20. Do you save money systematically?.....
21. Do you like good music and good reading?....
22. Have you ambition to be of real service to Humanity?.....
23. Do you seek good advice and helpful associates?
24. Is your leisure spent profitably?.....
25. Are your relaxations pleasant and helpful?....

One of the secrets of fighting fires effectively is in being able to get on the scene as soon as the fire starts with some means of extinguishing the fire. An easy and effective method of sending a hose to the roof of a building is by means of an endless chain with sprocket wheels at the roof and near the ground. The lower wheel is attached to a crank and some form of hook carries the nozzle end of the hose to the roof. This device has been employed in some factories as an auxiliary fire protection.

Liquid Anhydrous Ammonia*

How It Works as a Heat Vehicle. Proper Handling of the Regulating Valve. By Albert Johnson

THE word "vehicle" may mean anything from a wheelbarrow to a flying machine, and vehicles are put to many uses; but the vehicle I will dwell upon is one used to convey millions upon millions of heat units from insulated cooling rooms and whatever you keep therein to the outside of your building, and there dump or unload them. For in order to make your rooms cold you must remove the heat, otherwise nothing would become cold, since what we call "cold" is nothing but absence of heat. Cold is a condition, not a form of energy, such as heat is well known to be.

Heat can be measured. For instance, the heat necessary to raise the temperature of one pound of pure water one degree Fahrenheit, say from 60 to 61 deg. F., is commonly called a British thermal unit, and is known as a B.t.u. On the other hand, we can remove one B.t.u. from the pound of water by cooling it from 60 to 59 deg. F., and if we continue removing the B.t.u.'s from said water, we will soon have a pound of ice instead of a pound of water, for a ton of ice is simply a ton of water with the heat removed. The water shows no loss of weight by removing the heat, which proves that heat cannot be weighed, but it can be measured by its effect.

The heat contained in the water, or in a cooling room, must be carried away to produce the condition called cold. A vehicle of some kind must cart the heat away, just the same as a vehicle is necessary to cart away a carload of sand or grain. If the wagon holds a large load and is cleanly unloaded, your carload of material is soon unloaded, but if the wagon holds a small load and also brings back unloaded material in the bottom of the wagon which the unloader did not remove, you will find it expensive to unload that car. Yet in both cases the car was unloaded, except that one method was costlier than the other. It pays to have a good vehicle.

A peculiar thing about heat is that it is really "motions of molecules," each molecule beating or vibrating against the other at a terrific speed. Yet with all of its activity, it positively refuses to go anywhere unless it is carried by some substance. It must have substance to travel in. A vacuum stops the travel of heat units on this account.

Without a substance or vehicle to carry it away our heat would not move out of the ice box. A vehicle is absolutely necessary, one that can be run without wheels or sideboards, and yet carry a full load of heat units, also to load and unload automatically. This self-loading and self-dumping heat-carrying vehicle for the present purposes we will call liquid anhydrous ammonia—and please bear in mind I use the term "vehicle" only to illustrate more clearly our subject.

Liquid Anhydrous Ammonia

Not many years ago, the working of anhydrous ammonia was surrounded by more or less mystery, for all that the average person knew was that by the use of ammonia somehow or other the storage rooms became cold. In those days it mattered not how much fuel was consumed or how many cylinder-heads were blown out, or how much ammonia was lost, or how much extra water was used or wasted, or how much piston rod packing was frozen and ruined.

But in these days of close profits and fierce competition each one is watching the efficiency end of his plant with an eagle eye. And woe to him who fails in this, for he will be the loser, for the profits of next year may come from the waste of today.

How Ammonia Conveys Heat

Let us now see how anhydrous ammonia becomes a conveyor of heat. When one pound of anhydrous ammonia has passed through the regulating valve into the low pressure pipes it remains a liquid until it can grab hold of from 500 to 600 B.t.u. of heat. Then the pound of liquid changes into a pound of gas. But it refuses to change from liquid to gas until that much heat leaves the room and enters the liquid ammonia on the inside of the coils, thereby turning it into gas.

This changing of the liquid into gas is what absorbs the heat. Therefore, it is always necessary to have plenty of liquid ammonia within the low-pressure pipes.

Do not, under any circumstances, allow gas to pass through the regulating valve, for then you only add heat to your rooms instead of subtracting it. Remember, the gas is the loaded vehicle, while the liquid is the unloaded vehicle, being empty. The liquid has plenty of room for heat units, but the gas has very little room for heat units, since it is already loaded with them. It cannot carry any more. So it is well to watch and see that only liquid passes the regulating valve into the low pressure pipes.

Bear in mind that it requires heat to vaporize ammonia—the more heat, the quicker the evaporation; whereas, the less the heat, the slower the evaporation. Which explains why "sharp freezers" are so apt to fill up with liquid in abundance, while the rest of the system may be suffering from the lack of liquid.

After the liquid has been changed into vapor by the heat, it has practically lost its value as a refrigerant, for the gas has obtained its full load of heat and is ready to carry it away.

Use of the Refrigerating Machine

So far the ammonia, or vehicle, has been we might say "running down hill," requiring no power. At the bottom of the hill is the loading platform where the heat is taken aboard. After this it's an uphill pull, and a good strong horse is required to pull it up to the unloading platform. The horse may be called a "refrigerating machine."

The machine gets behind the heat-laden gases in the frosted low pressure pipes, and pushes them up to the top of the hill to the unloading platform, or ammonia condenser, where the loaded gas is changed back into a liquid. Just at the moment when the gas becomes a

*From a paper before the Middle States Ice Producers' Convention.

liquid it releases or dumps out the heat that it formerly picked up in the rooms, and the water at the condenser then absorbs the released heat units and carries them away.

Thus we see how necessary is the refrigerating machine to push the loaded vehicle, ammonia, along the uphill grade of high pressures direct to the top or unloading place at the condenser. But that is all it has to do, for the real work of freezing is performed by the ammonia, not by the machine. The initial as well as the final operation is done by the vehicle called ammonia, which must not be forgotten.

Thus you can readily see how anhydrous ammonia actually becomes a so-called vehicle for removing heat units from your insulated rooms and carrying them, with the aid of the refrigerating machine, upstairs or downstairs, around corners and angles to your condensers, there to unload this heat. Then the ammonia goes back to repeat the operation, year in and year out.

Wrong Name for a Valve

The regulating valve controls the flow of liquid ammonia into the low-pressure pipes; that is all it is there to do. It cannot do any freezing, since only the ammonia does that. I mention this so clearly because, way back in the early days of this industry, somebody misnamed that valve—the expansion valve—without thinking of the consequences.

Ever since then many operators get the erroneous idea that this valve actually does the heavy work of freezing, and they fuss over it and play with it, sometimes resetting it 20 times a day, then listen to hear the gas gurgle or spit through it. The misnaming of this valve has cost the owners of plants hundreds of thousands of dollars in time lost fooling with it, and in lack of efficiency caused by relying on this valve during critical moments of climbing temperatures, when the receiver should be watched instead. It is best to call it a regulating valve, to save confusion of ideas, much money and false impressions.

When I speak of heat-laden gases in your suction pipes it may surprise you. Try to put your hand on a frost-covered suction line and imagine it contains real heat. It actually does, and lots of it, only it is called latent heat, or insensible heat. A thermometer cannot register it, nor can you feel it by touch; but it is there just the same. Apparently the pipe is very cold, for it is usually covered with frost, yet the cold gas inside of that pipe will deliver heat enough to warm up enormous quantities of condensing water from 10 to 30 deg. F. per lb.—and that is a lot of real heat!

We see how the vehicle ammonia is relied upon to take the initiative in the work of removing heat. It is essential to work with not only dry, but pure ammonia. Note the difference between dryness and purity, for volatile hydro-carbons may exist in the very liquid itself, which causes abnormally high pressures. Such foul gases refuse to liquefy and fill up the condensers.

These bad gases must be blown away. Hydro-carbon gases are both colorless and odorless, which makes them hard to find by tests. They are hidden, and like latent heat we know them only by the effect they produce when they refuse to liquefy, causing excessive fuel bills or power bills and great ammonia consumption.

It has been estimated that in order to purge 15 lb. of uncondensable or hydro-carbon gas from the system you lose 85 lb. of pure gas, because the 2 are closely associated or intermingled, so that when the purge valve is opened the good as well as the bad gases are unavoidably liberated together.

Good Ammonia Requires No Purging

Good ammonia requires no purging, for good ammonia is free from volatile hydro-carbons. The evaporation test does not disclose the presence of volatile carbon compounds, for they evaporate together with the ammonia. The working test seems to be the most reliable. The test for air in shipping cylinders means very little as to quality, and has the disadvantage of being deceptive.

Ammonia requires a working test to prove its effectiveness, rather than analysis. However, in making an exhaustive examination of ammonia a thorough chemist will demand to see the raw material as well as the finished product. In testing cement, for instance, a thorough chemist will also examine the klinker or raw material as well, in order to obtain data for proper valuation. The klinker may be overburnt or underburnt, and the chemist is right in demanding a sample of the raw material.

Two Methods of Making Ammonia

Now, it so happens that there are 2 methods of making ammonia, for anhydrous ammonia is a compound. There are various qualities of each process.

One process is called the direct process, because the ammonia is distilled direct from gas-house liquor. The other process is called the sulphate process, because sulphate ammonia is the raw material instead of the crude gas liquor itself. The ammonia gas contained in the gas liquor is absorbed in sulphuric acid, and in forming the crystallized sulphate, ammonia is subjected to a powerful process of purification. In addition to this, I will add that skill and knowledge cut some figure, as well.

The purchase of anhydrous ammonia should be like the hiring of a man. You expect a man to perform some service and keep on doing so. In purchasing ammonia you must expect it to serve you by picking up or absorbing all the heat units possible and unloading them in large quantities day by day, without getting tired or worn out on the slightest occasion. Remember, you do not buy ammonia like other merchandise, to be sold to others from the shelf. Instead of that, you invest your money in an article that must work for you day and night, and produce results in heat-carrying capacity. For to produce one ton of refrigerating duty the vehicle ammonia must fetch and carry away 288,000 B.t.u. of heat from your insulated rooms in the shortest possible time, and that is why the question of ammonia as a heat vehicle is so serious as to affect the profits in a refrigerating plant.

A good rule to follow when banking fires on a hand-fired grate is to clean the fires before banking; bank them in front of the furnace doors and cover them with fresh fuel; close the ashpit doors; leave the fire doors open a bare crack and open the damper slightly to prevent an accumulation and a possible explosion of furnace gas

LETTERS DIRECT FROM THE PLANT

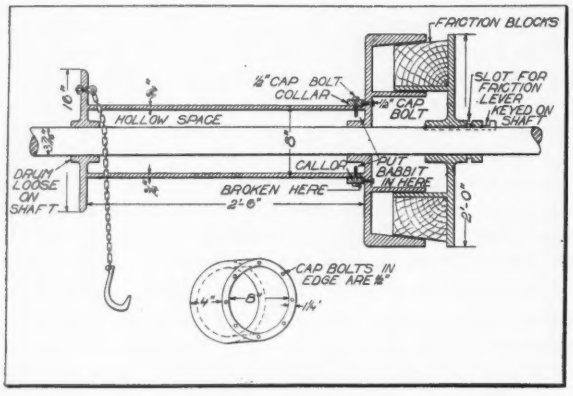
Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Repairing a Broken Drum

HEREWITH IS a sketch of a cast-iron drum that was broken in a plant where I was employed and repaired by me. Until this break-down occurred, I did not know that, prior to my employment, there had been a similar break-down which laid the plant up for 4 days, and as it was used to turn the logs on a carriage in a sawmill that had a sawing capacity of 90 M per day of 10 hr., nothing could be done until it was either repaired or a new one installed. In the case of the first break-down, a new casting was installed which took 4 days to get.

In the case of the second break-down, the manager was away, but they knew where he was going, and they wired him.

He wired back: "Tell Ben to see what he can do; will be home this evening."



REPAIR TO BROKEN DRUM

I was already on the spot, and as generally is the case, quite a crowd of the boys had collected around, all waiting to see what I was going to do. I sized things up and told some of them to take it to the shop.

I took the friction end of the drum, which still had about 1½ in. left on, being broken almost perfectly square off, put it into the lathe, turned the rounding shoulder off and faced it so my band would fit up square to it.

Next, I drilled 6 holes far enough out that they would go into the center of the edge of the band after it was shrunk on, got a piece of 1¼ by 4-in. mild steel, figured out how much stock it would take to make my band, allowed enough to turn up in the lathe to make it perfectly true, cut it off the bar, turned it up and welded it together. As soon as I could get it into the lathe, I turned it true on the inside, faced the edge next to the edge of the drum and allowed a shrinking fit.

I put it into the forge again and turned the blast on while I got my 2 broken pieces ready. I matched them together so as to get the break together right and marked them, leaving the large end on the floor, which left the 1½-in. end up. By this time, my band was hot enough to put on. I dropped the band over the short end and lifted the other up and set it down into the band so my points corresponded and cooled my band just enough to keep it from expanding my casting in the center and breaking it, as a casting expanded in the center and not on the outer edge will sometimes break.

I next set my drum up on its end, drilled down into the edge of my band and tapped the holes to take 1½-in. cap bolts into the edge. I then drilled and tapped 4 holes into the outer edge of the face of the band and screwed bolts into them and cut them off flush with the face.

I then had a space between the hub of the drum and outside wall on the inside of the drum, just under my band. I took a piece of gas pipe and ran it down through the other end of the drum and poured babbit enough to fill it up flush with the end of the hub.

I was then ready to put it back, which I did, and the plant resumed operations the next morning. This drum turned the log that broke it and has been in active service ever since—more than 2 yr.

It is needless to say that when the manager returned, he came and saw what I was doing, he was highly pleased and complimented me for my efforts in trying to get the plant in operation again.

Afterwards, at the first opportunity I had, I got the pieces of the one that had broken first and repaired it in the same way, and had it ready for a similar emergency.

B. A. PITCHER.

A Few Dollars vs. Several Hundred

AN INSTANCE has just been called to my attention where the owner of a small power plant thought he would have to buy a more powerful engine because his present engine did not do the work.

His machines were belt driven throughout. The main drive was a belt drive.

By chance a belt expert learned of the owner's predicament and went to look the plant over. He was pleased to find that he could be of considerable service to the owner for the belts were in bad shape; they were all running tight and slipping and consuming a great deal of energy.

The belt expert, instead of making the belts still tighter, as most engineers seem to have the natural impulse to do, applied a good belt treatment, stopped the slip, and as soon as the belts were in proper condition for

it he slackened them as much as possible. They now run "easily"; they do not slip; the journals do not get hot; the friction load has been reduced to the minimum; and the engine is pulling the load without difficulty. The owner could even drive more machines than he is now driving without increasing his power.

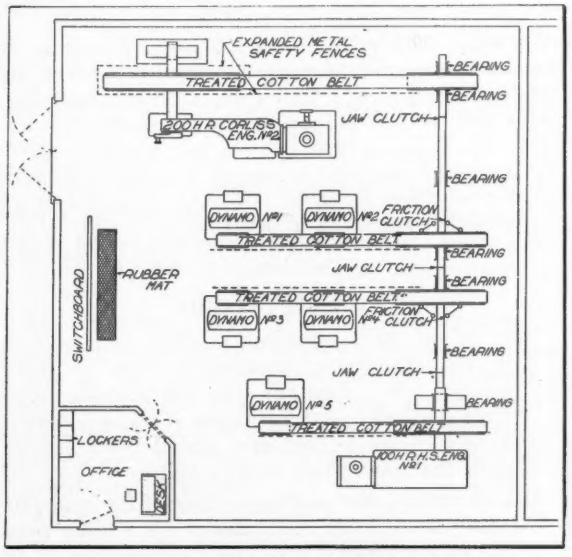
These "little" things are always well worth looking after.

A larger engine would have done the work, sure enough, with belts in bad condition. But why spend several hundred dollars when proper expenditure of 2 or 3 dollars will save that expense? N. G. NEAR.

Small Central Station Layout

I HAVE READ with considerable interest the article by J. W. Dickson, on page 409 of the April 15 issue, alluding to the plan of driving shafting by 2 engines, namely: high speed engine with a shaft governor, and a Corliss engine.

The accompanying drawing shows in a general way a plan designed by C. M. Gidding, some years ago, which is typical of quite a number that were put in about that time and succeeding years, which, as far as the writer knows, have proven very economical and satisfactory and possess a number of important points.



FLEXIBLE SMALL PLANT LAYOUT

This particular electric light station, like many others, has a high speed steam engine in it that was too small to carry the load, and it was also desirable to improve the economy of the station and decrease the coal consumption, therefore a Corliss engine was added to the station so as to drive the line shaft by means of belt and dental clutches and to enable the load to be thrown from one engine to the other. The governor of the Corliss engine was fitted with a small lever and a sliding weight, thus by moving this weight upon the lever in such a manner that it would cause the Corliss engine to run faster the Corliss engine would take all the load and the clutch at the high speed automatic engine could be easily thrown out and the high speed engine stopped, and in the like manner when the load on the station became light, the high speed engine could be started up and thrown on the line shaft and the weight of the Corliss engine governor lever moved in the opposite direction and the clutch connecting Corliss engine driven belt pulley could be easily thrown out.

It was the common practice in this station to use both engines on the line shaft at the peak of the load on Saturday nights and other times when the load was unusually heavy, while at other times the line shaft would be driven by whichever engine was most suitable, thus resulting in a most economical electric power plant both in first cost and also in operating expense. I say first cost, because the cost of the electric installation was very small compared to the direct connected slow speed units that are now fashionable.

A station of this design will probably not be suitable for use in a city where the price of land is very high, but for the smaller cities and towns it seems to be particularly well adapted. F. W. SALMON.

Effect of Keying Up on Clearance

IN THE May 15 issue, page 500, Mr. Hawkins has answered some questions for J. W. D., all of which are very good, short and right to the point but I should like to add a little to question number 7. If you key up on the crank end only, what difference would it make with the clearance? The answer given is correct for practically all engines, with one exception. The Westinghouse Company builds an engine with a connecting rod so arranged that the wedge on the crank end takes up not only the wear of the crankpin box, but the wear of the crosshead box as well. The wedge being back of the crankpin, the distance between centers is increased as stated and the clearance decreased. Of course, all depends on the type of connecting rod end used on the engine. In this engine, it would decrease the clearance more than on any other, as it tightens the brasses on both the crank and the crosshead pins at the same time.

Number 8. If you had an open heater and were getting water at a temperature of 200 deg. F. and you wanted it hotter, what would you do? These last 4 words are the whole question in a nutshell, and I must say, from my own experience, it depends entirely on the conditions under which it is necessary to operate the plant with the apparatus, piping and equipment it may have.

The answer given to the first part of the inquiry states that weighting down the back pressure valve to get a back pressure of 3 to 4 lb. on the heater would give the extra heat desired to the feed water. This is very true, but let me ask what effect this back pressure may have on the engine? Does it not require that much more steam to be used in the cylinder on the opposite side of the piston to overcome and equalize this pressure you have added? And how much more water would the feed pump have to handle to produce it, and how much more coal would be required to evaporate it into steam at the required pressure?

The economy of such a practice depends largely on the kind of engine; for a Corliss using about 18 lb. water per horsepower hour would not be as expensive as a simple engine which uses 34 to 45 lb. of water per

horsepower hour. Under these conditions would it not be better economy to burn a little more coal under the boiler to heat the water the desired 10 or 20 deg., than to try to raise this temperature by adding back pressure on the engine when it is not necessary? In most steam plants when an open heater is used and the engine rating is anywhere near the horsepower rating of the boiler, there is usually sufficient steam exhausted to heat the feed water, if the engine is working properly and the heater is in good condition, unless there is much hot water taken from the heater for other purposes.

The temperature of the feed water passing from a closed heater depends on the temperature of the water entering the heater, the amount of steam exhausted into it, the temperature of the steam and the number of coils through which the feed water passes before going to the boiler. But the water cannot be hotter than the temperature of the steam entering the heater.

It is good economy to extract or utilize all the heat possible from the exhaust steam before allowing it to escape to the atmosphere, but not to a point where it will bring an unnecessary load on the engine.

R. A. CULTRA.

Packing Lubricator; Some Handy Tools

THE MAJORITY of engines in use today are equipped with metallic packing on the piston rods. On a short stroke engine, the packing receives sufficient lubrication from the crosshead oiler, or from the splash oiling system when used; but on long stroke engines, it is advisable to provide special lubrication for the rod. One of the most convenient methods of doing this is as shown in Fig. 1. A hole is drilled through the frame over the stuffing box and tapped for a ⅜-in. pipe thread. Screw a ⅜ by ⅛-in. bushing into the bottom, and into this a short piece of ⅛-in. pipe bent in such shape that the drops of oil will strike directly on top of the rod, immediately in front of the gland. A plain glass-body oil cup of the desired size with a ⅜-in. shank is then screwed in the top. When located in this position, the

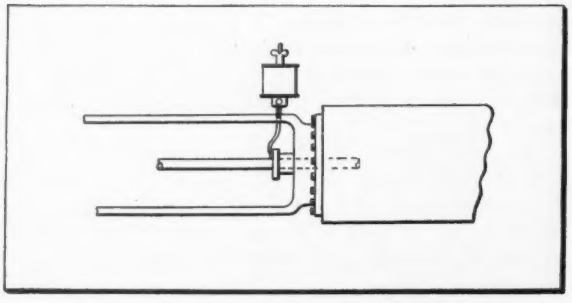


FIG. 1. LUBRICATOR FOR STUFFING BOX PACKING

cup is accessible for filling, and the regulation of the feed may be easily seen at all times. Cylinder oil should be used, but only a small quantity is required.

A convenient tool for use about the plant in marking a shaft and wheel hub or eccentric, and for many other uses, is a chisel with the bit formed at an angle to the center line, as shown in Fig. 2, instead of perpendicular to it. This tool is not new, but may have been forgotten by some engineers. It is made of ⅝-in. octagonal steel about 8 in. long. The angle of the 2 edges is about 80 deg., which allows the point to strike first. Then, by changing the position of the tool slightly, the mark may be extended on either side to the length of the edge.

Another handy tool is a square wedge about 6 in. long made of ½-in. square steel tapered down to ¼ in. square at the end. The sides are planed flat, thereby giving a sharp corner, and the tool is tempered hard,

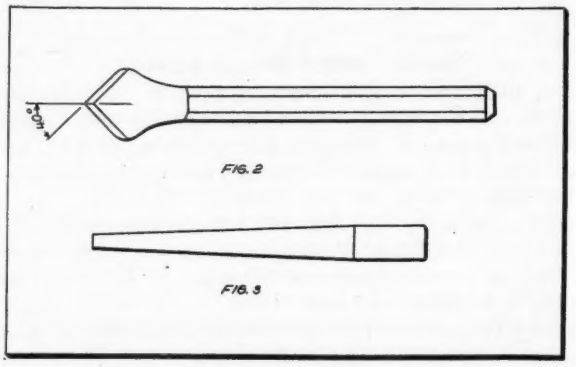


FIG. 2. MARKING TOOL FIG. 3. SQUARE WEDGE

full length. This is handy as a tapered reamer or to remove a broken pipe bushing or a stud bolt which has been twisted off flush. To remove a broken stud, first drill a hole in the end and drive the wedge in quite tight. The sharp corners will cut into the stub, and it may be turned out with a monkey wrench. The taper should not be over ⅜ in. to the foot. A set consisting of several sizes should be in every engine room.

J. C. HAWKINS.

Receiver Pressure

ONE OF the open questions to many engineers is, what is the best receiver pressure to carry to obtain best results. Some maintain that the pressure which will divide the load equally between the 2 cylinders of a compound engine is best, and that a more uniform rotation of the crank shaft is the result.

Others contend that, as the principle of the compound is to reduce the cylinder condensation for a given range of initial and condenser pressures, the pressure in the receiver is best which will allow a drop in temperature in each cylinder of 0.5 of the total range.

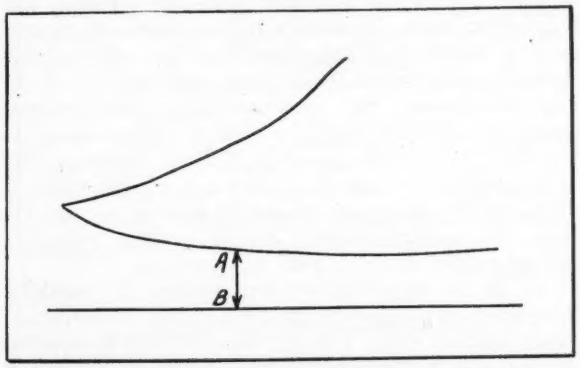
The writer has charge of a plant containing compound engines, one of which is so loaded at certain seasons that should the receiver pressure be fixed from the above, the engine could not carry the load up to speed. So the low pressure cutoff is handled like this: The low-pressure cutoff is shortened, thus raising the receiver pressure until, with the steam pressure in the boilers carried to within a pound of the blowing point, and a 24.5-in. vacuum, the engine can carry the load. The final result, insofar as distribution of load goes, is that the low-pressure cylinder develops about 200 hp. more than the high, and may be accounted for as follows:

While it is true that as the receiver pressure is raised, the mean effective pressure in the high-pressure

cylinder is reduced, owing to an increased back pressure; it is also true that such raising of the receiver pressure has likewise increased the initial into the low, and thus raised its mean effective pressure, and consequently a gain in horsepower output for the engine is obtained.

It is not claimed that such procedure increases economy for it does not; yet the engine must be made to carry the load, if possible.

Some may think that the foregoing would put too much load on the low-pressure parts; but all reputable builders so proportion their machines, that they can safely carry all the load that may be obtained by changing the valve gear to any distribution of load between the 2 cylinders.



POINT ON HIGH PRESSURE CARD REPRESENTING RECEIVER PRESSURE

It may be said that builders are careful to send receiver pressure gages so graduated that they will not read as high a pressure as would be fatal to the safety of the low-pressure cylinder itself as received from the builders.

When one has a single eccentric on the high-pressure cylinder of a compound, and such eccentric is set back to give all the range of cutoff possible, one must be careful to measure the receiver pressure from the card as between the points A and B, which represents that registered by the indicator and should be depended upon more than the steam gage. RECEIVER.

Removing Bushings

WHILE DOING some repair work recently, the writer encountered something of a proposition in the removal of a considerable number of small, inconveniently located brass bushings; that is, insofar as their removal was concerned. The bushings in question were 1-in. brass about 1½ in. long, taking a pin about ¾ in. diameter. They were so located in connection with the valve motion of a vacuum pump that it was impossible to drive them out without damaging parts of the machine, and by stripping the parts a considerable delay to the plant would have been the result.

Figures 1 and 2 show how the bushings were quickly removed. As they were worn beyond the point of any further use, a tap was run into one end of the bushing far enough to secure 3 or 4 full good threads. One end of a machine stud was then run into the bushing and tightened. By using a nut the same size as the stud in connection with a couple of washers, one of which was larger than the bushing, it was quickly and easily removed in spite of its location. The new bushings were drawn in by the method shown in Fig. 3., which is not by any means new.

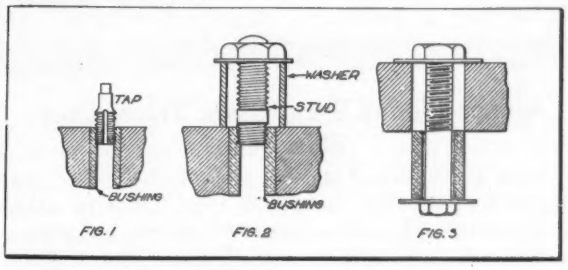


FIG. 1. TAPPING BUSHING FIG. 2. REMOVING BUSHING
FIG. 3. DRAWING IN NEW BUSHING

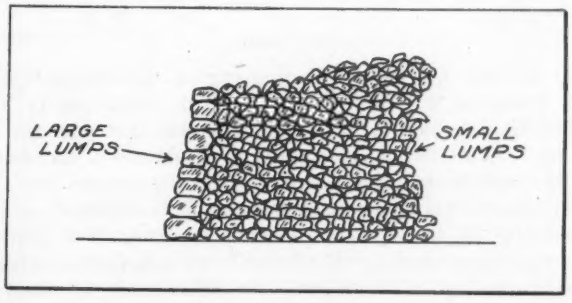
The writer has seen a good many instances where this kink could have been used to advantage, but where a removal of not a few parts was undertaken in order that such bushings might be driven out.

F. W. BENTLEY, JR.

Walls for Coal Storage Bins

WITH REFERENCE to H. E. Weightman's data on "Walls for Coal Storage Bins," I beg to call attention to a point that I have noticed in the piling of coal, and that is: the large lumps usually roll to the bottom or to the edge, as the case may be, and there form a sort of wall in themselves. This occurs when the coal is dumped into the center "on top" of the pile as with a grab bucket.

I would, therefore, figure that with walls designed as suggested by Mr. Weightman they would be amply safe.



METHOD OF PILING COAL FOR STORAGE

To illustrate further, I have seen huge piles of coal, 15 ft. high or more, stored out of doors by railroad companies, piled as indicated in the sketch herewith. The large lumps were carefully laid on the outside almost vertically, as shown. No trouble was experienced in the walls bulging out or breaking, which proves in my mind that coal thrust is not very great, especially with bituminous. To be sure, the finer the coal the greater will be the pressure, and with many of our coals the above would not hold at all—buckwheat, and pea coals for instance.

N. G. NEAR.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Composition of Spent Gases; Transformer Efficiency

DOES ANY chemical change take place in an internal combustion engine of the 2-cycle type, after the crude oil enters the combustion chamber until the spent gases are exhausted through the exhaust port of the engine?

Will these gases change when coming in contact with the atmosphere after leaving the exhaust port of the engine?

Are these gases injurious to the health of one constantly breathing them?

2. If you have a 10-kv.a., series incandescent regulator and are drawing 6.6 amp. at 1500 v. and at 97 per cent power factor and the transformer is connected to step down the primary voltage from 2200 to 1600 v. secondary, does the regulator take care of this other 100 v. which is not required, or must there be enough lamps in series to take care of 1600 v.?

3. Why are horn lightning arresters, and not other types, used on series incandescent lighting systems?

4. I would like to find the full-load and half-load efficiency of a 5-kw., 2000 to 200-v., 60-cycle transformer, having an iron loss of 70 w., a primary resistance of 10.1 ohms, and a secondary resistance of 0.066 ohms.

5. Is there any difference between the construction of 2 alternators, one rated 100 kv.a. and the other 100 kw., both machines having the same voltage, same number of poles and running at the same speed?

W. H. H.

ANSWERS

IN ANY internal combustion engine, the charge that is drawn in is a mixture of air with either gas or a vaporized liquid fuel. In the oil engine that you mention, it is a finely divided spray of crude oil. This mixture must be in the right proportions to give an explosive action when the spark passes. This explosion is a burning of the fuel, and changes the mixture from hydrocarbons and air (the latter being largely a mixture of oxygen and nitrogen) to carbon dioxide, carbon monoxide, water vapor and nitrogen, the proportions depending entirely on the kind of fuel, and the ratio of air to fuel in the charge.

Most of the gases after explosion will consist of carbon dioxide, carbon monoxide and nitrogen. The nitrogen is not changed in the explosion. There is no change of these gases as they are exhausted to the air, since the temperature has, by that time, been lowered, so that the carbon monoxide will not burn to carbon dioxide. You can tell whether there is much carbon monoxide by the appearance of the exhaust gas. If this is clear, or contains only a little whitish vapor that looks like steam, the combustion is practically complete. If there is a bluish tinge, it means that unburned fuel and carbon monoxide are escaping.

The carbon dioxide is not poisonous, but simply chokes off the lungs from getting a proper supply of oxygen. The carbon monoxide is an active poison, and if breathed in any quantities, affects the blood, usually causing nausea and headaches, and also affecting the eyesight. If work is to be done where one has to be near the exhaust from such an engine, arrangements should be made to carry away these exhaust gases so that they will not be breathed, as there is almost sure to be a certain amount of the carbon monoxide, which is distinctly injurious, and always the air will become foul from the heavy mixture of carbon dioxide, which has the same effect as choking off the breath.

2. In the series incandescent system, the regulator is inserted on purpose to take care of any excess voltage above that for which it is set. Usually such a regulator can be adjusted within a moderate range, so that it would be able to hold the voltage from the transformer at 1600 v. down to 1500. If it were set for 1600 v. regulation, and the lamps in circuit were only sufficient to take care of 1500 v., you might have trouble with too frequent burning out of the lamps. This will depend somewhat on the style of regulator that you have and its action.

3. There is no special reason for the use of horn lightning arresters more than of any other kind. It is simply a matter of choice of the engineers who design the system. The horn arrester has been found very effective in blowing out an arc which may be drawn by the discharge of lightning, but any other effective type will serve.

4. For the efficiency of your transformer, the primary current at full load will be 5000 divided by 2000, or 2.5 amp. This squared and times the primary resistance, 10.1 ohms, gives 63.125 w. In the secondary, the current is 5000 divided by 200, equals 25 amp., and this squared times the secondary resistance 0.006, equals 41.25 w. The sum of these 2 plus 70 w. iron loss, gives 174.375 w. The efficiency is, then, 5000 divided by 5174.4 equals 0.966, or 96.6 per cent.

In like manner, for half load, the primary current is 1.25 amp., and the primary loss 15.8 w. The secondary current is 12.5 amp., and the loss 10.35. The iron loss is constant, so that the sum of these 3 is 96.15 w., and the efficiency will be 2500 divided by 2596.15 equals 0.964, or 96.4 per cent.

5. The difference between a kv.a. rating and a kw. rating, depends upon the conditions under which the machine runs. You are aware, of course, that the kw. output of a machine depends on the voltage, the current and the power factor, or the difference in phase between

the current and the voltage. If the power factor is 100 per cent, the kv.a. rating and the kw. rating will be the same. If, on the other hand, we have a circuit heavily loaded with induction motors, so that the power factor is down to 80 per cent, the kv.a. rating will be the kilovolts times the amperes, while the kw. rating will be the kilovolts times the amperes times the power factor, 0.8.

For modern machines, alternating-current units are seldom rated in kw., since the capacity of the machine is limited by the heating effect of current in the armature. The machine can safely carry the same armature current whether it is operating at 100 per cent or 80 per cent power factor. The kv.a. rating would be the same in both cases, but the kw. rating would be different according to the power factor of the circuit. It is not safe, therefore, to rate an alternating-current unit on kw., because if this rating is made for 100 per cent power factor, and we draw the same load as shown on the wattmeter when the power factor is 80 per cent, the armature will be overheated; while if we rate kw. capacity, at a power factor of, say, 85 per cent, the machine will be unduly expensive as compared with the manufacturer, who might rate at 100 per cent power factor.

A. L. R.

Care of Motor Brushes

SHOULD THE brushes on a motor be taken out or lifted from the commutator when through running, particularly if the motor is hot? Brushes are carbon or graphite. What harm occurs if removed? If left on? Does it amount to much if they are not touched? This pertains to a d. c. motor on a motor truck. W. H. C.

A. It is not necessary, and it may even be inadvisable, after a motor or generator is shut down, to remove the brushes; in fact, more harm can be done if the brushes are removed than if they are left in place. If the brushes are removed after they have worn themselves to the proper surface, it is probable that, when replacing them, they will not assume the same position on the surface of the commutator, causing the brush to make a contact at a point or edge instead of on the entire surface, resulting in sparking and consequent deterioration of both brush and commutator. O. H. H.

Perfect Combustion

WHAT DO you consider as perfect combustion?

SUBSCRIBER.

A. Perfect combustion is something that is never attained, even under the best conditions, owing to the endless variety of conditions attending the consuming of fuel for industrial purposes. The heating value of coals differs widely in various parts of the country, and even in the same locality there is considerable difference. Indeed, this feature can be carried so far, that the different veins, or strata, in the same mine, or, astonishing as it may seem, in adjacent parts of the same vein, differ considerably. Then, furnace design is an ever increasing perplexity, and again, the standing of the thermometer and barometer must also be taken into consideration.

But under ordinary conditions in order to burn any kind of fuel successfully, one must make a close study of the problem, not only in a general way, but also in the instance at hand, in order to secure the necessary amount of air at the proper time and keep the excess air reduced to a minimum.

The best results are obtained when the boiler is carrying full load or more; but if this cannot always be done, as sometimes happens, especially in a small plant, then the grate area should be reduced by stopping off part of it with firebrick, properly placed, until proper combustion is secured.

When one enters into the field of flue gas analysis, he has opened up a subject, whereon volumes would but skim the surface. While a fireman may be so fortunate as to obtain as high as 14 per cent of CO_2, yet if he holds pretty well to 12 per cent he is doing well with the average boiler and furnace. GEO. H. WALLACE.

Making Blueprints

HOW CAN I make blueprints at home? What would I need for this? J. J.

A. This may be done quite easily. About the only things required are the blueprint paper, some sort of printing frame, and a basin for washing the prints. A printing frame can easily be made, consisting of a hinged glass cover which holds the tracing and blueprint paper against a smooth, flat surface during exposure.

The time required for exposure will, of course, vary according to the nature and intensity of the light. Generally the exposure is sufficient when the paper has turned to a dark blue, but this can be better determined by experiment.

Blueprinting may be done by exposure to sunlight, tungsten light, arc light, mercury vapor and Welsbach gas light; however, blueprints can not be successfully made from carbon filament lamps.

When the printing paper has been sufficiently exposed, it is washed by being immersed and passed through clean water until all the chemical is removed. This washing can be done in almost any shallow basin of convenient size. L. N. B.

Fire Cracks

WHAT IS a fire crack? Is it dangerous? What should be done when one is discovered? W. J. McK.

A. Fire cracks are small cracks that are found radiating from the rivets most exposed to the fire and are found most frequently in the girth seam of tubular boilers. Occasionally they will be found in the girth seam over the combustion chamber.

They are generally not over an inch long, but sometimes extend several inches into the sheet. Most of them, however, will be found extending from the rivet to the edge of the sheet.

It is practically impossible to calk a rivet crack effectually, as they are caused by unequal expansion and contraction assisted by scale settling on the sheets inside the boiler, and the cause will soon spoil the best job of calking.

If the crack runs into the sheet, drill a hole at the end of the crack and drive in a rivet, or screw in a plug, preferably copper, but be sure that you are at the end of the crack. Use a strong glass to determine where the end of the crack really is.

There is a certain amount of danger connected with the presence of fire cracks, no matter how small in number and size. They should be closely watched. If they defy a few careful treatments, take the first opportunity to cut out the cracked sheet and rivet in a strip.

They are also found in the side walls and crown sheets of locomotive type boilers, and where the staybolts or crown stays are all right, the crack can be stopped effectively till necessary to renew the sheet from general wear, by drilling at the end and screwing in a small copper plug, say, about ½ in. Then beside this and cutting into it a little, drill another hole and screw in another plug, and so on to the end next the rivet or staybolt where the crack started.

Rivet cracks will usually manifest themselves when the boiler is under service, and one should clean the shell carefully every time one cleans the inside, and look carefully for fire cracks, for like everything else in and about a boiler plant, unless it is attended to at the first opportunity after discovering it, a crack will develop to the point where it is a serious matter. G. H. WALLACE.

Boiler Trouble

WE HAVE 8 Stirling boilers, 7 250-hp., and 1 500-hp., the large boiler being on the end of the line and about 300 ft. from the engine. We carry a pressure of 150 lb. The steam nozzles on all boilers are 8-in. The steam drums on the small boilers are 52 in. in diameter and the large one 42 in. in diameter. Flat grates are used. The large boiler develops about 650 hp. with a hot fire and 2 gages of water. When all the load is thrown off the water will fall from 4 to 6 in. in the glass. The automatic feed valve will open and put the water back to 2 gages. Then when the load comes on and the fires are forced, the water at times will rise and blow out of the top of the column. On the other boilers, we never have any trouble of this kind. I contend that, owing to the smallness of the steam drum and steam nozzle, the steam issuing from the boiler has such a high velocity that it pulls the water up and that when the steam is not being drawn from the boiler it falls to its natural level again. I have advised that the steam nozzle be enlarged to about 12 in., thus giving a lower velocity and thereby avoid lifting the water. The master mechanic says that is not the correct remedy, but fails to say what will cure the trouble. He contends that the manufacturers would not build a boiler with a nozzle too small.

Can you suggest a different reason for this trouble? H. S.

A. We do not know of any boiler in which, if the load is suddenly cut off, the water line will not fluctuate. Your letter does not contain many details of the trouble you are having. It would appear, however, from the facts as you have given them, that the 7 smaller boilers are carrying the steady load of the plant and the large boiler is used to take care of variations in this load. When the load decreases, the large boiler is cut out of service automatically. If our assumption of this condition is correct, it would be better to have all of the boilers in operation carry their proportional part of the load and the variation could in all probability be satisfactorily taken care of by regulation of the main flue damper.

Your letter states that when the load is thrown off the boiler and the water level drops, the automatic feed regulator comes into action and rapidly brings the water back to 2 gages, so that when the load comes on, the fires are again forced and the water rises to an objectionable point. It appears from this statement that the automatic feed regulator is such that it makes possible only 2 conditions of feed supply, namely, full supply and no supply. A feed regulator which would give a truly graduated supply might help conditions. We understand that there are such regulators on the market.

There can be no object in increasing the size of the steam nozzle of the 500-hp. boiler. The steam velocity through this nozzle, when operating at 650 hp., is only about 2570 ft. per min., which in present practice is decidedly low.

A. D. PRATT, THE BABCOCK & WILCOX CO.

Proper Method of Feeding Boilers

KINDLY TELL me the proper place to feed a 250-hp. Scotch marine boiler.

2. What are the objections to feeding through the blowoff? A. B. H.

A. The proper location of feed line discharge in a Scotch marine boiler is not different from that employed for a return tubular boiler.

The feed line enters the front of the boiler and extends 3/5 the distance to the rear, then turns through an ell to near the side of the boiler and discharges down near the shell. This gives the incoming water a chance to heat somewhat, and discharges it in the direction of natural circulation in the cool part of the boiler.

2. The objections to feeding a boiler through the blowoff are that, when it is desired to blow off the boiler, the scale-forming material, which naturally would settle near the blowoff opening, has been removed by the incoming feed water, depositing it most likely in some part of the boiler where it will do damage to the tubes or plates. R. E. T.

Piping Color Schemes

I WOULD LIKE to know of some standard color scheme for painting power station piping where different colors are used to distinguish different pipes. Where can I obtain a chart of standard colors, showing on what pipe line each color is used? R. F. B.

A. There is no scheme of colors for a piping system which is recognized universally as a standard, but a system which has been used by many plants, was described by Wm. H. Bryan in June, 1908, in a paper before the American Society of Mechanical Engineers. This was somewhat incomplete, and, as a result of the study of this and the system of the U. S. Navy, with some others, a system was adopted by a Commission of German Engineers, which is given in the October, 1912, issue of Practical Engineer. The general scheme was as follows:

Water, green; gas, yellow; air, blue; steam, white; tar, black; oil, brown; vacuum, grey; alkaline chemicals, pink; acid chemicals, pink with red stripes. This follows in general the same colors as given by Mr. Bryan. A. L. R.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Gas Engine Cards

I AM SENDING a set of cards taken from one of our engines after running 2 months and before any changes were made in valve or ignitor setting. I would be pleased to know the opinions of other gas engineers in regard to them. The engine is a 24 by 48-in. twin tandem driving compressors 15½ by 48 in.

NAT G. PUMPER.

Paraffin on Commutators

H. G. H. ASKS FOR the opinion of those who have used paraffin on commutators. Several years ago, the writer was employed in a plant where it was customary to use paraffin on the commutators. There had been considerable trouble from sparking and chattering of brushes, which was greatly benefited by the use of paraffin. This was melted and molded into sticks about ¾ in. square by 4 in. long and rubbed on the revolving commutator 2 or 3 times a day.

The brushes were hard carbon and had poor lubricating qualities, and the paraffin prevented them from cutting the commutator. During the past few years, however, brushes have been designed into which a sufficient amount of lubricant in the form of graphite has been introduced, and with which no further lubricant is necessary. These graphite brushes are softer than the carbon brush and wear out somewhat more rapidly than the carbon.

Sometimes paraffin or commutator compound is used on a commutator to prevent sparking or chattering, a trouble which is not due to lack of lubrication but rather to high mica between the bars. The commutator may be worn rough due to cutting caused by hard unlubricated brushes or dirt. The proper remedy in this case is not to dope the commutator, which has a tendency to increase the resistance between it and the brush, but to remove the cause of the trouble.

In the case of some motors that give trouble from sparking, paraffin might be beneficial; but a softer grade of brush would probably accomplish the same results.

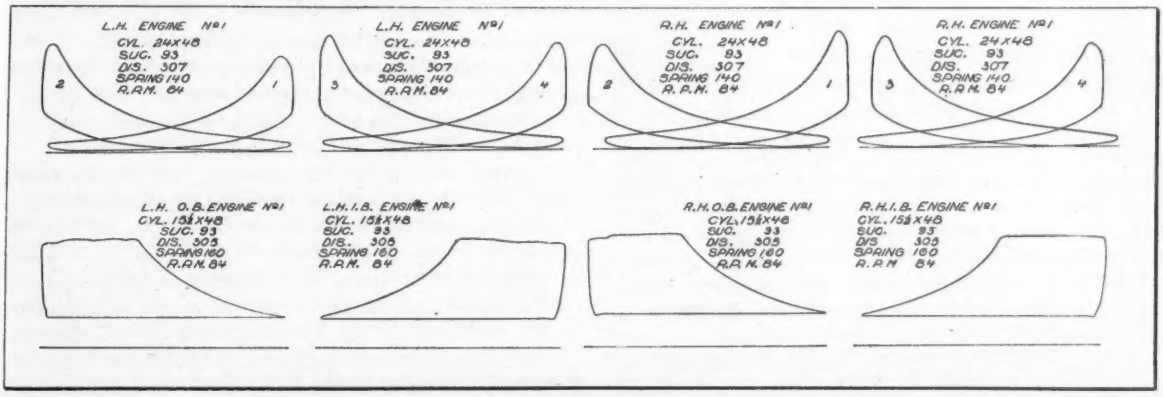
Sometimes it is only necessary to put in a few soft brushes, say one on each stud, staggering them across the width of the commutator. This provides all the lubrication that is necessary, and, although paraffin can do no harm other than to increase the resistance between the brush and commutator, it is not necessary where the proper brush is used.

J. C. HAWKINS.

IN REGARD to the inquiry about the use of paraffin on commutators, I have found the use of paraffin in the following combination very satisfactory: 5 lb. of paraffin wax, 5 oz. of beeswax, 5 tablespoons of cylinder oil, 1 tablespoon of glycerin, 3 tablespoons of "air floating" graphite.

The first two should be melted and the others added. Care should be taken that the graphite is thoroughly stirred in. The mixture may be poured into molds of a shape convenient for use. Molds may be made by using the tapering part of a broom handle for wrapping a piece of tin around; after the tin is wrapped around the handle, it may be held in shape by means of small wires. The broom handle may then be removed, a cork put in the small end of the tin, and the mold is ready. A mold as long as 18 in. or 2 ft. may be made this way and after the mixture has cooled, the compound may be cut in convenient lengths.

L. B. HEDGE.



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Developments in the Boiler Room

Improvement in the overall efficiency of boiler rooms, which has been particularly noticeable in the last few years, is not all due to the manufactured equipment, although due credit must be given to the manufacturers who have carried on experiments and investigations at enormous expense; much is due to those who have laid out the plant and designed the special boiler settings and furnaces; but above all credit must be given to the men who have the operation of the plant in charge.

While in the engine room the best minds in the engineering field have been able to develop machinery which is almost independent of geographical location, and will maintain operating conditions so constant that only a small variation in efficiency results from great changes in load, and apparatus needs but comparatively little attention from week to week, entirely different conditions exist in the boiler room. Equipment which gives the very highest efficiency in one plant may, under slightly different operating conditions, fall far short of even good results.

It has been but a few years since anthracite coal was used almost exclusively in eastern cities and when the equipment for and art of burning this kind of coal under power boilers had been brought to a satisfactory point, it was found that anthracite was getting to a prohibitive price. With the use of bituminous coal in furnaces designed for anthracite, smoke was produced and municipal authorities took a hand in the regulation of power plant affairs. To the credit of many cities, interference by the smoke inspectors has aroused the interest of power plant owners more especially in the boiler rooms, and has probably been the most potent cause of the present move towards boiler room efficiency.

Bituminous coals of varying grades have demanded special study, experiments and investigations resulting in stokers operating on different principles and furnace construction unthought of in days when anthracite was plentiful.

Coming strictly to the operating side of the question, it is only a short time since instruments for analyzing flue gas have become seriously thought of as necessities in the power plant. A study of draft losses through different types of setting is today considered a most important factor in operation, and will indicate many conditions to the fireman which are of vital importance to efficient management of his fires and boilers. Keeping the boiler clean both inside and out are extremely important factors, and the method employed and the frequency which gives best results must be worked out in each individual plant.

Investigations along any of these lines will repay any man in charge of a plant. A series of articles is now being published in Practical Engineer dealing with these subjects, which we hope will aid our readers in solving some of the difficulties which they have encountered in the operation of their boiler rooms. In this issue we report the results of a series of tests, which are along the line of investigation, and important discussions by prominent engineers which point out clearly that further development in the efficiency of boiler rooms must come largely from the operators.

News Notes

AT THE ANNUAL meeting of the National Gas Engine Association, to be held at the Brevoort Hotel, Chicago, June 23 and 24, the program calls for routine business on the morning of the 23rd, the meeting being called to order at 10:30. In the afternoon, papers will be taken up on "The Future Work of the Association," "The Gathering of Data by the Association," "Standardization of Machinery," Report of the Insurance Committee, and in the evening at 7:30, Report on Cost Accounting. On the 24th, the morning session will be called at 9:30, and papers taken up on "Educating the Buyer to Your Type of Engine," "Farmers' Development as the Buyer of Motors," Report of Committee on Legislation. In the afternoon, at the 1:30 session, "Possibilities of Farm Lighting" will be discussed, "The Magneto of the Future," "What of the Kerosene Engine," and Report of the Publicity Committee.

A dinner will be served at 6 p. m. in one of the private dining rooms, and election of officers will be held. The meeting is to be at the Brevoort Hotel, 120 W. Madison St. (one-half block east from the LaSalle Hotel). The hotel rates will be $1.50 to $3 for single rooms without bath, and $2.50 to $5 with bath.

THE NEW ENGLAND STATES ASSOCIATION of Stationary Engineers will hold their annual convention at Holyoke, Mass., July 7 to 10. The exhibition to be held in connection with this will be opened at 8 p. m. on Wednesday, at which hour all exhibits must be completed, and the exhibit will close on Friday night, so that all packing can be done on Saturday morning, leaving the afternoon free to attend the festivities. Further information in regard to the exhibition can be had from L. L. Warren, Secretary, Equitable Building, Boston, Mass.

PENNSYLVANIA STATE CONVENTION of the National Association of Stationary Engineers is to meet at Pittsburgh, June 18, the sessions continuing over 2 days. Headquarters will be at the Monongahela House, in that city, where all sessions also will be held. The committee in charge of the local arrangements for the convention, which is made up from the membership of the 3 local associations in Pittsburgh, is preparing an elaborate entertainment and inspection program. The chairman of the Pittsburgh committee on arrangements is George A. BuMiller; L. S. Evans (care Lawrence Paint Co., Pittsburgh), is secretary.

NEW ENGLAND ASSOCIATION of Commercial Engineers is working on plans for a Permanent Machinery Exhibit for the City of Boston, and has selected the new building now under construction at the corner of Oliver and Franklin Sts., where they will use the basement and the first 2 floors as Exhibit and Lecture Halls. It is contemplated making this building headquarters for meetings of engineering and mechanical societies, as well as the permanent home for the Machinery Exhibit. As at present planned, the exhibit should open on Oct. 1, and has the sanction of the Boston Development Board of the City of Boston, so that there is every prospect of success. Further information can be obtained from Lewis L. Warren, manager, 308 Equitable Bldg., Boston, Mass.

THE FOLLOWING resolution was passed recently by the Trenton Association:

Whereas: The brothers and members of the Trenton Association, No. 4, of the National Association of Stationary Engineers, deeply pained at the untimely and tragic death of our esteemed fellow member, Arthur R. Foley, at the time of the torpedoing of the Lusitania, desire to express our unspeakable sorrow at the loss of one whose ever wise counsel and example as a citizen and friend we shall ever hold in loving remembrance.

Whereas: We desire to place on record our high appreciation of his character, and to convey our sincere sympathy to his bereaved wife and family; be it:

Resolved that a copy of these resolutions be recorded on the minutes, and an engrossed copy be sent to the sorrowing family of our departed brother.

Committee: E. A. Corbett, J. F. Lightford, John Mycock, T. L. Woolf.

JAMES BEGGS & Co., manufacturers of the Blackburn-Smith feed water filter and grease extractor and the Beggs sewage ejector system, announce that they have opened an office in Saginaw, Mich., and in Cleveland, Ohio. Their representatives at these points will give prompt attention to inquiries received from the State of Michigan and the northern part of the State of Ohio respectively.

MCINTOSH & SEYMOUR CORPORATION, Auburn, N. Y., has appointed V. E. Raggio, 1107 Nevada St., El Paso, Texas, to represent the company in Arizona, New Mexico, Texas west of a line drawn north and south through Del Rio, and the States of Sinaloa, Sonora, Chihuahua and Durango, in Old Mexico.

H. H. DAY, of Toledo, Ohio, night fireman at the Ohio Building, was, unfortunately, scalded in the blowing out of a tube which had recently been installed in the boiler, the force of the explosion hurling the body some 20 ft. across the engine room. This and the scalding resulted in death, which occurred on May 29.

EFFORT IS BEING MADE to bring the rules of the Massachusetts Board of Boiler Rules into entire agreement with the Standard Specifications as adopted by the American Society of Mechanical Engineers' Committee. There is, at present, but slight difference, and it is hoped that co-operation and entire agreement may be secured. A petition has been presented to the Board of Boiler Rules by Thomas E. Durban, Chairman of the Committee on Standard Uniform Specifications of the American Boiler Manufacturers' Association, National Tubular Boiler Makers' Association, and National Association of Thresher Manufacturers, which 3 organizations include practically all boiler makers in the country.

The petition asks that boilers constructed according to the Code of the A. S. M. E., and duly certified by an authorized inspector, should be accepted for use in the State of Massachusetts. The petition has not yet been acted upon, but the Board of Boiler Rules, by its Chairman, has accepted an invitation to be present at the meeting in Pittsburgh on June 21 to 23, when the matter of progress and adoption of the Standard Specifications, and further action to secure its universal adoption, will be taken up.

Central Steam Supply

PAPERS AND DISCUSSIONS PRESENTED AT THE SEVENTH ANNUAL CONVENTION OF THE NATIONAL DISTRICT HEATING ASSOCIATION, CHICAGO, JUNE 1 TO 3

THE convention, held at Hotel Sherman, was notable as having the largest attendance in the history of the Association, the widest representation from all parts of the country, most active and practical discussion on the different papers, and the finest and most instructive exhibit of apparatus for distribution and control of steam.

As is customary in conventions, the first session on the morning of June 1 was devoted to addresses of welcome and response, the president's address, reports of committees and routine business.

CONCENTRATION IN FUEL BURNING

OPENING the afternoon session, was an address by J. F. Gilchrist, of the Commonwealth-Edison Co., of Chicago, who spoke largely upon the importance of concentration in the supplying of power and heat, and of the effect which such concentration has upon economical use of fuel. In part he said: As heat is an elementary requirement of the human race, the heating business is based on a fundamental need, hence has somewhat of an advantage over the supplying of light and power, which are secondary in point of necessity.

Concentration in the production of steam or power means a saving in labor, the possibility of using higher grade fuel, and better economy in using fuel, partly because of the more economical equipment used, partly because of better attention and higher grade labor being employed in burning the fuel.

The use of the high grade fuel and better plant has, also, civic advantages, as it reduces fire hazard, reduces the smoke produced, minimizes the ash handling, and therefore reduces street traffic.

As a matter of conservation of coal supply, it is possible that the making of power and steam in large plants rather than small individual plants may result in a reduction of our national coal consumption, instead of the steady increase which has been the rule in the past. Approximately the total coal used per year is 517,000,000 tons. Of this 27,000,000 tons is burned in central stations, 10,000,000 tons by street railways and interurbans, 100,000,000 tons by steam railways, leaving 380,000,000 tons for industrial and domestic use. This latter figure may be divided roughly as 240,000,000 tons for industrial power and the heating of institutions and buildings, and 140,000,000 tons for domestic use.

The amount of coal for power furnished by central stations is roughly 10 per cent of the total coal requirements of the country, this being provided by 37,000,000 tons of coal burned and hydraulic power to the equivalent of burning 17,000,000 tons, or about 54,000,000 tons total as the coal equivalent of central station power, including that used by street and interurban railways. The actual power furnished by central stations, including the hydraulic developments, is much more than 10 per cent of the total power used in the country; hence, if all power and heating requirements were furnished by central stations, the coal required would naturally be much less than the present requirements, since the 380,000,000 tons used for industrial plants and domestic purposes would be greatly decreased.

Central heating is a natural monopoly, the same as the supply of electric current, telephone service and street railways, and should be so recognized, and regulated as to the rights and the rates, the same as any other monopoly, and in consequence protected in its monopoly to avoid duplication of plant and distributing system, and increased expense to the community.

BLEEDER TURBINES

THE PAPER on the operation of bleeder turbines was then presented by F. W. Laas, of Cedar Rapids, Ia., who stated that early experiences with this type indicated that, with the turbines then available, better results were obtained, in the special conditions he encountered, by running the turbine condensing, and using direct steam from the boiler for heating; and when compound condensing engines were tried with the bleeding from the receiver, it was found that better results were secured by running the engine noncondensing, with a back pressure of some 25 lb., and a receiver pressure of 50 lb., and using the entire amount of exhaust steam for the heating system.

These conclusions do not pertain to the present bleeder turbines, which have been designed in accordance with past experience, and are arranged to give a constant steam pressure on the heating system, taking steam from the second stage, regardless of the electrical load, and are, also, designed to give a high economy when running condensing during the non-heating season.

HEATING AND RADIATION CONSTANTS

FOLLOWING THIS paper, the report of the Educational Committee was presented by D. S. Boyden, this report being divided into 4 parts, treating on Standard Coefficients for the Transmission Lines from Buildings, Standard Coefficients for Proportioning Direct Radiation Mains and Returns, Standard Coefficients for the Effect of Wind on Heat Loss, and Standardization of Heating Elements for Cooking Apparatus. A great mass of valuable data and information was presented, which will be abstracted and given at length in a future issue.

In the discussion on this paper, it was brought out that the coefficient for radiation from the radiating surface varies with the position of the radiator in the room and with the finish of the radiator; that so far as variation of this coefficient with difference in temperature between the steam and the room is concerned, there seems to be no regular variation,—in fact, the coefficient will vary at different times with the same temperature difference and apparently the same conditions. This coefficient on tests has shown a variation from 1.72 with the bare iron of the radiator down to 1.46 when finished with aluminum bronze, and a slight variation of about 0.05 B.t.u. is found when an insulating sheet is put between the radiator and the wall. It was considered

that more study is needed before any standard coefficient can be established for radiating surface.

In reply to questions as to the value of a reflecting material placed behind the radiator, it was stated that what is needed is an insulating material, which will change the action from radiation to the wall to a convection by the current of air passing upward about the radiator.

Low-Pressure Steam for Kitchens

In the discussion on the use of low pressure steam for heating kitchen and industrial utensils, such as kettles, water-heaters and glue pots, the need of apparatus designed to use low-pressure steam was brought out, since most apparatus for such purposes has heretofore been designed to take steam at 30 to 60 lb., but experiments show that the use of the high-pressure steam is, on the whole, not needed, provided mains and returns of sufficient size are installed, and the heating elements designed with sufficient surface to give the required heat transmission.

In one instance it was found that, with vacuum stills, the reduction of pressure from 60 lb. to 3 lb. increased the output, for the reason that the 60-lb. steam blew through so rapidly that it gave little time for condensation.

Numerous examples were given where, with proper design and repiping, hotels, restaurants and industrial plants had found that they could use steam at from 3 to 6 lb. with as good success as they had previously used 60 lb. The changes involved were increased radiating surface for direct heating, the use of full jackets on kettles in place of half jackets, installation of larger coils in water heating urns, plate warmers and similar devices, the use of a larger header in the kitchen, with all low points trapped so as to keep the system clear of condensation and allow the full area of the pipe for steam flow. It was also found that the use of a manifold instead of a continuous coil assisted in certain types of apparatus.

One instance was given where the reducing of the openings in the supply lines to a laundry, without any change in the steam pressure, cut the amount of steam used 50 per cent, showing that an entirely unnecessary amount of steam had been allowed to blow through the system.

New Officers

Election of officers at this session resulted in the choice of D. S. Boyden, of Boston, as President; Byron T. Gifford, Grand Rapids, First Vice President; George W. Martin, of New York, Second Vice President; Wm. S. Monroe, Chicago, Third Vice President; D. L. Gaskill, Greenville, O., Secretary-Treasurer; and on the Executive Committee, C. F. Oehlman, of Denver, and Thomas Donohue, of LaFayette, Ind.

Large Hot Water Heating

The session on Thursday morning took up the paper on Hot Water Heating System of the Grand Central Terminal, by W. G. Carlton. The hot water system was chosen for this building, which has a maximum of 28 stories in height, because of the fact that it is a railroad terminal, with a heavily congested traffic, and the use of steam, which might fill the train sheds, through a break or leak in the heating system, was practically barred. The hot water is circulated from the terminal service plant at 50th St. by pumps located on the first floor of the plant, at approximately street level.

As to the advantage in ordinary central station distribution as between hot water and steam, the opinion was advanced that this depends entirely on the individual circumstances. In theory there is no advantage of one over the other. In practice, the hot water system can be so controlled as to regulate the use of heat by the customer, instead of the customer regulating the amount of heat furnished to him, and in this way, the hot water plant may have a better capacity for the same amount of exhaust steam available than the steam plant.

Station Operation

In the report of the Station Operating Committee, which followed, stress was laid on the necessity for studying operating conditions as they stand, to see where there may be inefficient methods of making tests of performance with standard conditions, and with the conditions and methods of operation changed, and determining what ways of operation give the best economy. The records of a number of tests were given and analyzed, and the operating conditions in a number of different stations discussed.

Discussing this paper, Joseph Harrington, of Chicago, emphasized strongly the necessity of keeping sharp track of the actual daily performance of a plant after the best operating conditions have been established. He has found that, in some plants, returning after 30 days, the routine of operation has been allowed to sag to a point where it has reduced the efficiency of the plant some 10 per cent. Keeping of records, either manually or by means of recording instruments, without inspection or analysis, is of little value. The rendering of daily reports, and plotting these on log sheets so that comparison can be made from day to day and from month to month, in plant performance, gives a quick and illuminating check on what the plant is doing each day.

The points on which Mr. Harrington asks for daily reports in the plants in his charge are the number of boilers in service, the total hours that each one runs, turbine units in service, total hours of running for each, the machine load factor, total water used, the total coal used, the total kilowatt-hours generated, also the average vacuum, in inches. He asks, also, for the coal analysis and the ash analysis, from time to time, but does not insist that this shall be made every day. The quantities asked for in the coal analysis are the usual values, and in the ash analysis, the moisture and the percentage of combustible in the ash, and the percentage of ash to the total fuel. He asks, also, for the average flue temperature, the average carbon dioxide at the damper, the average draft loss from each boiler, as feed water temperature passing to the economizer and to the boiler.

In plotting out the load log for the plant, these values are embodied in curves, as well as the feed water per kilowatt-hour, the coal per kilowatt-hour, and the evaporation per pound of coal for each day.

Speaking of furnace conditions, Mr. Higgins gave an account of some experiences with the use of powdered fuel. He classed the underfeed stoker furnace as a gas producer, in which the gas is made on the grates and burned in the furnace. He stated that the use of powdered fuel eliminates one stage of this operation, since, in its finely divided form, the fuel practically burns as a gas when it enters the furnace.

Investigation of the system, which is in use by the American Locomotive Co., at Schenectady, and which is known as the Quigley System, shows that on a 300-hp. Heine boiler, powdered fuel is being burned to give a carbon dioxide value of 17 to 18.5 per cent. This requires the maintenance of a very high temperature in the furnace, calling for a firebrick which will stand up to this intense heat, and he understands that a brick is now being perfected and will soon be on the market which will withstand 3500 deg. F., and permit of the maintaining in the combustion chamber of a temperature of 2800 deg. In the tests, it has been found that it is necessary to have some 20 ft. of flame travel to complete the combustion before the gases strike the heating surface of the boiler tubes. The Indiana coal, which has been sent to Schenectady for test, produces considerable slag, but this is in a form which can readily be removed. The ratio of air to coal is maintained at 4 to 1, with a coal feed varied automatically in accordance with the boiler pressure. Some difficulty has been encountered in the weighing of the fuel, but this was finally taken care of by putting the fuel in bags, weighing these, then dumping the fuel into the hoppers and weighing the bags to get the net amount of coal.

Estimating the weight of the coal from the cubic capacity as of no value in the case of powdered fuel, since there is so much air, and the amount of air contained is so variable that the results might err by a large percentage.

The main drawback to this system, at the present time, is the cost of preparing the fuel. It must first be dried to a moisture of half of one per cent in the dryer, or it cannot be handled by the blower. It is then crushed to a fineness such that 85 per cent of the fuel will pass through a 200 mesh to the inch screen, and in this form can be handled by worm conveyors to almost any distance, successful handling having been accomplished up to 2000 ft., or it can be pumped, by the application of compressed air, to the surface of the fuel, in much the same way as a liquid.

In a visit to the plant at Schenectady, it was apparent that the danger of handling the fuel had been minimized, since no particular attention was paid to the handling of it, and an inexpensive grade of labor was employed in this work.

In doing the crushing, the cost with a 5-ton plant, for overhead and fixed charges, and power at a rate of one cent per kilowatt-hour, was found to be from 30 to 50 cents a ton, and the question arises whether the added efficiency from the use of the powdered fuel will pay for the crushing.

In comment on the matter of water softening, one plant was mentioned where the installation of a system of the Northern Water Softener Co. in a 3000-kw. plant could be made so as to reduce the hardness from 22 grains to 5 grains per gallon, at an installation cost of $2500, while to reduce the hardness to practically zero, the plant required would cost $20,000, and the increased expenditure was not deemed advisable.

Mr. Vater, in reply, stated, that the desirability of softening to a very low point of hardness depends on the conditions and the materials which make up this hardness. If the incrusting materials are such as to form porous scale, softening below 4 grains to the gallon is probably not worth while, but if the incrustants, such as sulphates of lime and magnesia, which form hard crystalline scale, are more than 20 per cent of the total incrustants, the scale will be very difficult to remove, and will be a very effective insulator against heat transmission, so that, if the plant is to be forced above its rated capacity, a great amount of trouble will be encountered from the scale formed.

Live Steam vs. Exhaust

At the afternoon session on Thursday, the first paper taken up gave the results of a pressure survey on the central heating system at Pekin, Ill., to compare the conditions existing throughout the piping system when using live steam and when using exhaust steam. Some discussion of the results will be taken up in a later issue.

In the comment on this paper, the old argument as to the advantage of using live steam or exhaust steam for heating popped up, and many advocates were found on both sides. One point brought out was that, when using live steam for heating, it should be made at the lowest possible pressure and still do the work; that the making of steam at a high pressure and passing it through a reducing valve was not good practice, considered from a heating standpoint, although it may be necessary when using steam from the same boiler for both power and heating.

Cases were cited where claim had been made that exhaust steam gave proper heating, whereas live steam, passed through the bypass, did not do the work so well as when passed through the engine, but investigation showed that the bypass for live steam was not large enough, and that when this was changed, the same effectiveness of heating was secured with live steam as with exhaust steam.

Two points brought out were, that in passing the steam through an engine, from 15 to 20 per cent of it is condensed, hence must be removed from the exhaust steam before sent to the heating systm, and this becomes a loss so far as the heating is concerned, whereas the live steam passed through a bypass and slightly superheated carries 100 per cent of its heat to the heating system.

One point in the use of the exhaust steam under some circumstances was brought out, namely, that with the exhaust steam from the engine, the amount of steam supplied to the system is regulated to a certain extent, and if the rooms are not warm enough, the customers may take steps to avoid waste by keeping windows closed and preventing heat waste, whereas with live steam, the steam is flowing in unlimited quantities, and any excess of temperature is remedied by the opening of windows to get rid of the heat. In some conditions, this may explain why the live steam appears to be more expensive than exhaust steam for heating purposes.

What would seem to be a reasonably conclusive test, which is to be made by one company, was mentioned, where the business of the company is entirely to sell steam. In order to find out whether the exhaust steam is more valuable, this company proposes to install a complete generating unit and a water rheostat. They will use as much of the current as possible for lighting and the small power requirements of the station, the balance will be wasted through the rheostat, so as to furnish exhaust steam to the heating system. In this way, it is proposed to try out thoroughly the question of whether there is any virtue in the exhaust steam over the direct steam.

A number of instances were mentioned where the boiler capacity in service was reduced with the coming on of the electrical peak load, which gave ample exhaust steam for the heating, and did away with the bypassing of live steam to the heating system, and statements of firemen that the boilers are handled easier with peak load than with light load. The question was raised whether this might not be due, in part, to the fact that with peak load, the entire force is keyed up to do its best, and maintained the best possible conditions of firing, feeding and draft, whereas in the light load periods, these conditions may be allowed to become worse from the combustion standpoint. On one investigation it was found that with large buildings, more coal was required when using live steam than when using exhaust, but in small buildings the reverse was true.

In comment on the tests, the need of longer tests when getting the fuel consumption from boilers was pointed out, also the necessity for making sure that comparisons of the effectiveness of live and exhaust steam be made with exactly parallel conditions in both cases. The case of the Capitol Building, at Madison, Wis., was mentioned, where a careful keeping of the feed water curve shows no difference whether the lights are on or off. There is a considerable lighting load, and when this is on, the heating is largely by exhaust steam, while with the lights off, the heating is largely by direct steam, and the heating conditions remain practically constant.

At the close of the convention, resolutions of thanks were extended to the management of the Hotel Sherman, to the Entertainment Committee, and to the exhibitors, whose presence largely added to the interest of the convention.

Exhibits and Entertainment

Continual diversion and instruction were to be found in the exhibit room which was at all times well filled.

Many displays dealt with material for underground distribution lines, but special devices for the plant and the customers installation were also in evidence.

Following is a list of the firms exhibiting and some principal lines of product:

American District Steam Co., No. Tonawanda, N. Y. Underground construction by wooden stave pipe and by air cell covering, variators, meters, water heaters and atmospheric vapor system.

American Radiator Co., Detroit, Mich. Sylphon specialties, valves, traps, radiators.

Armstrong Cork & Insulation Co., Pittsburgh, Pa. Nonpareil High Pressure covering, brine pipe covering, cork board insulation, insulating brick and insulating cement.

V. D. Anderson Co., Cleveland, O. Traps, safety water columns, separators, and air traps.

Boylston Steam Specialty Co., Chicago, Ill. Steam traps, reducing valves, regulating valves, back-pressure valves, pump regulators, separators and exhaust heads.

Consolidated Engineering Co., Chicago, Ill. Van Auken system of vacuum heating and heating specialties; and hermograde modulation system of heating.

Central Station Steam Co., Detroit, Mich. Condensation meters, Wrights traps and Detroit screens, water heaters, expansion joints, and underground line fittings.

Cannelton Sewer Pipe Co., Cannelton, Ind. Vitrified conduit and fittings.

Detroit Lubricator Co., Detroit, Mich. Packless radiator valves and multiport graduated vapor radiator valves.

G. M. Davis Regulator Co.. Chicago, Ill. Pressure regulating valves for all purposes, pump governors, traps and stop and check valves.

J. C. Horning, Chicago, Ill. Undreground expansion joints, differential and temperature control valves.

Illinois Engineering Co., Chicago, Ill. Automatic vacuum system of steam heating and modulating vapor system with complete apparatus.

Jenkins Bros., New York, N. Y. Heating specialties, including radiator valves, globe and gate valves, fractional radiator valves for vapor systems, air valves, back-pressure valves, packings and pump valves.

H. W. Johns-Manville Co., New York, N. Y., J-M Sectional Conduit and underground pipe covering system, insulation for pipes and boilers, subway boxes and packings.

Michigan Pipe Co., Bay City, Mich. Combination steel and wood water pipe, tin lined wood steam pipe casings for underground systems.

National Air Cell Covering Co., Brooklyn, N. Y. Pyrobestos waterproof underground pipe covering.

Republic Flow Meters Co., Chicago, Ill. Indicating and recording meters for near or distant register of pressure and flow of liquids and vapors.

Tyler Tube and Pipe Co., Chicago, Ill. Tyler Underground Heating Systems of piping in concrete ducts.

Westinghouse Electric and Mfg. Co., Pittsburgh, Pa. Photographs and descriptive matter of Leblanc condensers in jet and surface type, turbines and alternators, gas producers and stokers.

A. Wyckoff & Son Co., Elmira, N. Y. Wyckoff's steam pipe covering using cypress wood staves and air space insulation.

In addition to the exhibit features, the ladies were entertained by a musical and card party on Tuesday afternoon, shopping excursions on Wednesday and Thursday mornings and a lake excursion with buffet luncheon on the training ship Isle de Luzon Thursday afternoon; while the theater party on Tuesday evening and the banquet with dance following on Wednesday evening included all in attendance at the convention.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

High Resistance Bristol Pyrometer Instruments

A NEW line of high resistance thermo-electric pyrometers for temperatures up to 3000 deg. F. is being placed on the market by The Bristol Co., Waterbury, Conn. The millivoltmeter movements of these new instruments are all of the pivot jewel bearing dead beat type, and are made by the Weston Electrical Instrument Co. especially for use with thermo couples. These instruments may be used with Bristol patented base metal couples for measuring temperatures up to 2000 deg. F. and with standard platinum platinum rhodium couples or the Bristol patent compound couples with platinum platinum rhodium tips for measuring temperatures up to 3000 deg. F.

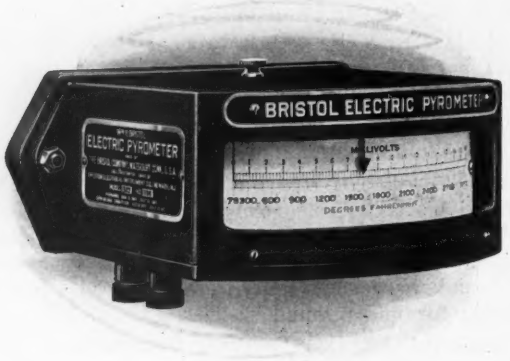


FIG. 1. WALL TYPE MILLIVOLTMETER FOR BRISTOL PYROMETER

In former issues the low resistance system of Bristol thermo-electric pyrometers were described as being suitable for temperatures up to 2000 deg. F. The low resistance system includes Weston pivot jewel bearing instruments and Bristol base metal couples which may be used together because the resistance of Bristol base metal couples is very low and changes of the resistance in the couple when heated in sections of varying length is negligible.

These new high resistance models can be used with standard platinum platinum rhodium couples for temperatures as high as 3000 deg. F. because the resistances of these instruments is so high that the change of resistance in the standard platinum couples are an extremely small and negligible percentage of the entire resistance of the circuit. Therefore, with these high resistance instruments, there are no appreciable errors due to ordinary changes of resistance in the circuit. They may be used under varying atmospheric temperature conditions and interchangeably with leads of various different lengths within certain limits.

Figure 1 is an illustration of the switchboard or wall type high resistance Model 319, and Fig. 2 is an illustration of the portable high resistance Model 322. When calibrated for scale range of 3000 deg. F. for use with platinum couples (or range approximately 18 M. V.) each of these instruments has more than 100 ohms resistance, and the temperature error of the instrument is consequently less than 1 per cent for a change of 25 Fahrenheit degrees.

FIG. 2. PORTABLE TYPE MILLIVOLTMETER

When calibrated for a scale range of 2000 deg. F. for use with base metal couple or for a range of approximately 65 M. V., the resistance of the instrument would be upward of 350 ohms and the temperature error of the instrument would consequently be less than 1 per cent for a change of 75 Fahrenheit degrees. This extremely high resistance also makes these instruments practically independent of length of leads and length of couples.

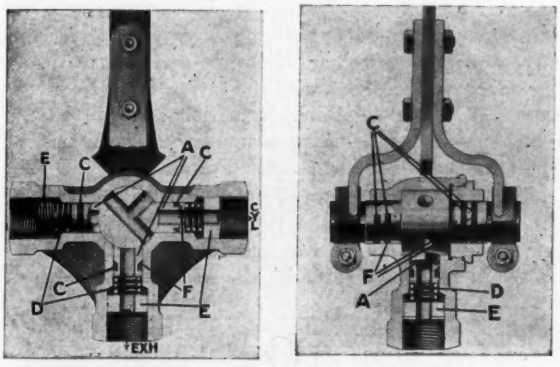
The high sensibility of these new instruments also makes them available for low ranges of temperature where an open scale is required.

High resistance instruments of this character embody the highest class of workmanship and construction. They are practical pyrometers for commercial and shop use having a very high degree of accuracy, and may be used with great flexibility.

Simplex-Caskey Hydraulic Valves

SIMPLEX-CASKEY valves, manufactured by the Yarnall-Waring Co., of Philadelphia, are so constructed that the higher the pressure becomes, the tighter the valves get. This is accomplished by the special features, which eliminate all stuffing-boxes and cup leathers. In the cuts herewith, parts marked A are extra long, special, soft bronze sealing bushings. Every time a valve is operated, the sealing bushings are again ground to the surface of the plug.

The sealing bushing is held tight against the plug by the spring, D, which is held in place by the retaining nut, E. The washers, C, are made of high grade hydraulic extra filled leather. Pressure is admitted behind these washers through holes F. Therefore, the higher the pressure the tighter the valve is packed by means of the leather washers. The plug is turned through an angle of 90 deg. and returned for a complete cycle of operation.



SECTIONAL VIEWS OF SIMPLEX-CASKEY VALVE

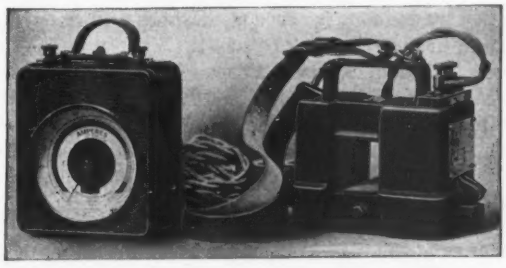
Simplex-Caskey valves are "pressure packed" and tight up to 10,000 lb. per sq. in. As the illustration shows, the plug opening allows full pipe area through the valve. The flow passes through the valve seat, not over it, thus reducing wear and cost of maintenance. There are no stuffing-boxes nor adjustments. These valves are noncorrosive, with bodies of hard, hydraulic bronze, and plugs of phosphor bronze or 30 per cent nickel steel.

Portable Current Testing Outfit

THERE are many uses in central station work for a high grade portable current testing outfit that combines accuracy and lightness with low first cost. Such an outfit with a capacity of from 75 to 250 amp. is now offered by the Westinghouse Electric & Mfg. Co. The transformer is so constructed that it can be clamped around any cable or feeder without opening the circuit, and therefore has a wide field of usefulness in testing cables in the power house, in manholes or on the line.

The standard outfit consists of a portable split-type current transformer, a type PR portable ammeter, a set of leads 10 ft. long and a leather carrying strap. The total weight of the outfit is less than 30 lb.

The split-type current transformer is made with a clamp at one end and a hinged joint at the other so that the 2 halves can be opened up, slipped over the cable, and clamped together tightly. The use of this trans-

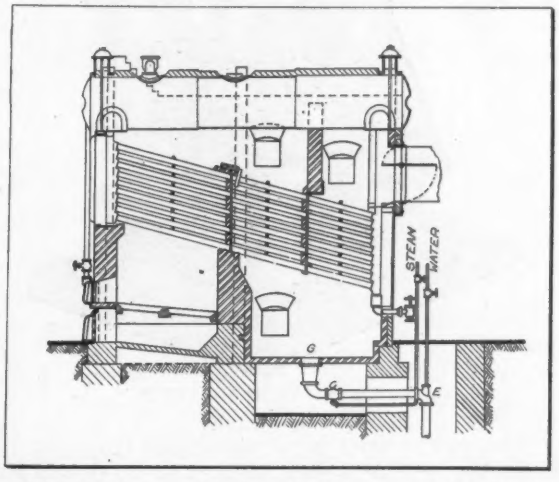


PORTABLE CURRENT TESTING OUTFIT CONSISTING OF AMMETER, CURRENT TRANSFORMER, CONNECTING LEADS AND LEATHER CARRYING STRAP

former obviates the necessity of opening the main circuit to make a test. By means of binding posts on the transformer, connections can be made for obtaining full scale readings of either 125 or 250 amp.

Soot Conveyors

WHEN the soot from the tubes of boilers is blown down, it collects on the floor of the dust settling chamber and ash pit. The soot falling in the ash pit is removed with the ashes, but that falling in the dust settling chamber is in most cases removed occasionally after a quantity has collected, by shoveling out through the clean-out doors. This operation necessarily involves time out of service for the boiler and labor.



APPLICATION OF JET CONVEYOR FOR REMOVING SOOT FROM PIT OF BOILER SETTING

The illustration shows application of a soot conveyor which removes the soot each time the tubes are cleaned.

The soot conveyor is operated by steam pressure, and is shown at C, installed in a pipe line which has connections to the combustion chamber of the various boilers. Each connection to the boiler is furnished with a slide gate, G, to cut in or cut out any particular boiler. Only

that slide gate to the boiler being cleaned is open, all other slide gates being closed. Steam is then admitted to the conveyor which creates a high vacuum, and the floating particles of soot are thus drawn into the conveyor system.

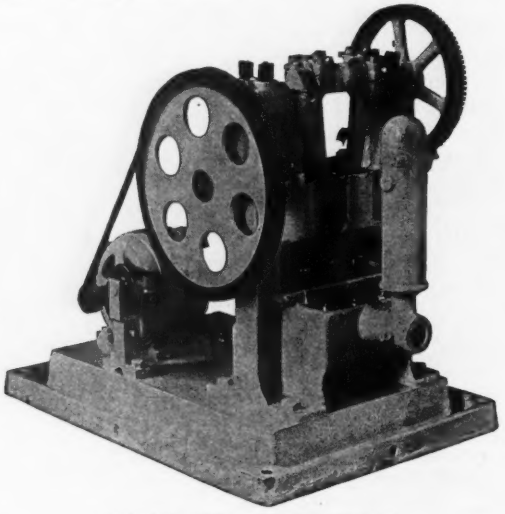
It is sometimes found that the amount of soot to be handled by the conveyor is considerable, and as the steam consumption of the conveyor is the same under all conditions, it is found that it makes a mixture after leaving the conveyor, which is not readily discharged, and for this reason, special elbows, E, are used, having bosses as shown, which are tapped for inserting centrifugal spray nozzles which inject water, and thus wash the soot down the discharge pipe.

As the water is under pressure, and the nozzle installed to discharge in the direction of the flow, this not only helps to wash the soot down, but the water issuing from the centrifugal nozzles gives added velocity sufficient to overcome any reasonable counter pressure.

The above-mentioned conveyors are manufactured by the Schutte & Koerting Co., Philadelphia, Pa.

Motor-Driven House Pump

IN the accompanying illustration is shown a pump particularly adapted for use on the farm, country estate or manufacturing establishment. Except for occasional lubrication, the outfit requires no attention or care, can be located in an out-of-the-way place and can be easily and safely controlled from a distant point by means of a simple switch.



MOTOR-DRIVEN HOUSE PUMP

The pump, which is of the triplex type with cylinders 1¼ by 2 in., is manufactured by the Goulds Mfg. Co., Seneca Falls, N. Y., and is driven by an ⅛-hp. Westinghouse electric motor. It will fill a 300-gal. tank, located 120 ft. above, in less than 3 hr. at a cost of approximately 5 cents, based on the usual cost of electricity.

DOING THE right thing at the right time and in the right way is efficiency. Furthermore, efficiency calls for good management.—Farm Engineering.

Catalog Notes

ELLIOTT BALANCED VALVES, float valves and piston valves are described and illustrated in a folder recently published by Elliott Co., Pittsburgh, Pa.

The company's Bulletin G deals with several varieties of Elliott steam traps.

THE BOOK "LATHES, their Construction and Operation," by G. W. Burley, a review of which was published on page 564 of our June 1 issue, may be secured from the D. Van Nostrand Co., 25 Park Place, New York, for $1.25 net, this company being the American distributors of this book.

THE GENERAL ELECTRIC CO. has just issued Bulletin No. 48,303, devoted to its Hand-Operated Starting Rheostats and Panels for Direct-Current Motors. These devices range in capacity from ⅛ to 500 hp., and are designed for use on 115, 230 and 550-v., direct-current circuits.

TWO SWITCHBOARD PUBLICATIONS, giving unusually complete information, have just been issued by the Westinghouse Electric & Mfg. Co., namely, Sections DS1439 and 1456, the former covering alternating-current boards with hand-operated switchboard-mounting oil circuit-breakers, and the latter, rotary converter panels. Complete detail information is given on these types of boards, including a number of diagrams, and suggestions as to the best method of assembly.

THE RELATION of Trolley Feeder Taps to Machine Flash-Overs, is the title of an article which recently appeared in the Electric Journal. This has been issued in pamphlet form by the Westinghouse Electric & Mfg. Co. (Reprint No. 10). The article discusses this question, giving the reasons for the application of the tap and the various conditions affecting the flash-over, quoting numerous incidents where rotary converters had flashed over.

AMONG ITS INVESTIGATIONS dealing with the means of lessening such dangers as attend the use of electricity in the mining industries, the Bureau of Mines has undertaken one that has for its purpose the establishment of permissible explosion-proof motors for use in places where an electric spark or flash might ignite inflammable gases or dusts.

Technical Paper 101, "Permissible Explosion-Proof Electric Motors for Mines; Conditions and Requirements for Test and Approval," which has just been issued, mentions the details of construction that the bureau considers essential for satisfactory service and describes tests of an explosion-proof mining-machine motor and accessories approved by the bureau. The author of this paper is H. H. Clark, electrical engineer.

The Bureau of Mines has applied the term "explosion-proof" to motors constructed so as to prevent the ignition of gas surrounding the motor by any sparks, flashes, or explosions of gas or of gas and coal dust that may occur within the motor casing.

Before it undertook to establish a list of permissible motors, the bureau made a large number of preliminary tests. No motors were approved as a result of this preliminary investigation, for none of the motors tested was considered to possess the characteristics of permissibility. As a direct result of these preliminary tests, however, the

These tables contain data especially worked out or carefully selected that are vital to

PRACTICAL ENGINEER

TOTAL HEAT OF ICE AND WATER

Temperature of ice t deg. F.	Difference in total heat per pound from ice at t to Ice at 32° $H_{ice}-H_t$ B.T.U./lb.	Difference in total heat per pound from ice at t to Water at 32° $h_{wat}-H_t$ B.T.U./lb.	Temperature of water t' deg. F.	Difference in total heat per pound from water at 32° to water at t' $h_{wat}-h_{wat}$ B.T.U./lb.
− 20	23.8	167.2	+32	0.0
− 18	22.9	166.3	34	2.0
− 16	22.1	165.5	36	4.0
− 14	21.3	164.7	38	6.0
− 12	20.4	163.8	40	8.1
− 10	19.6	163.0	42	10.1
− 8	18.7	162.1	44	12.1
− 6	17.9	161.3	46	14.1
− 4	17.0	160.4	48	16.1
− 2	16.1	159.5	50	18.1
0	15.2	158.6	52	20.1
+ 2	14.3	157.7	54	22.1
4	13.4	156.8	56	24.1
6	12.5	155.9	58	26.1
8	11.6	155.0	60	28.1
10	10.7	154.1	62	30.1
12	9.7	153.1	64	32.1
14	8.8	152.2	66	34.1
16	7.8	151.2	68	36.1
18	6.9	150.3	70	38.1
20	5.9	149.3	72	40.1
22	5.0	148.4	74	42.1
24	4.0	147.4	76	44.1
26	3.0	146.4	78	46.1
28	2.0	145.4	80	48.1
30	1.0	144.4	82	50.1
32	0.0	143.4	84	52.1
			86	54.1
			88	56.1
			90	58.0
			95	63.0
			100	68.0

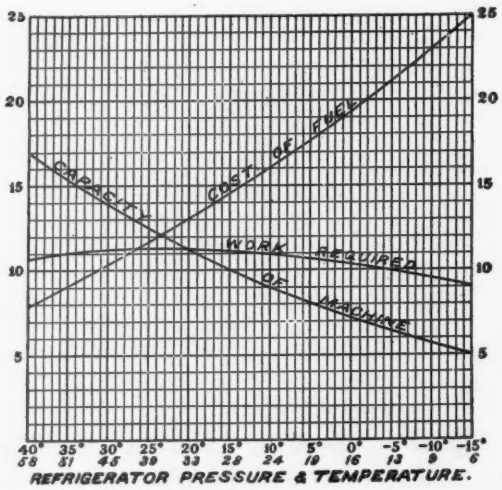
U. S. Bureau of Standards

PRACTICAL ENGINEER

ESTIMATES ON STORAGE BATTERY COSTS, INCLUDING ESTIMATED COMPARATIVE COSTS OF DELIVERING DAY CURRENT—WITH OIL ENGINES

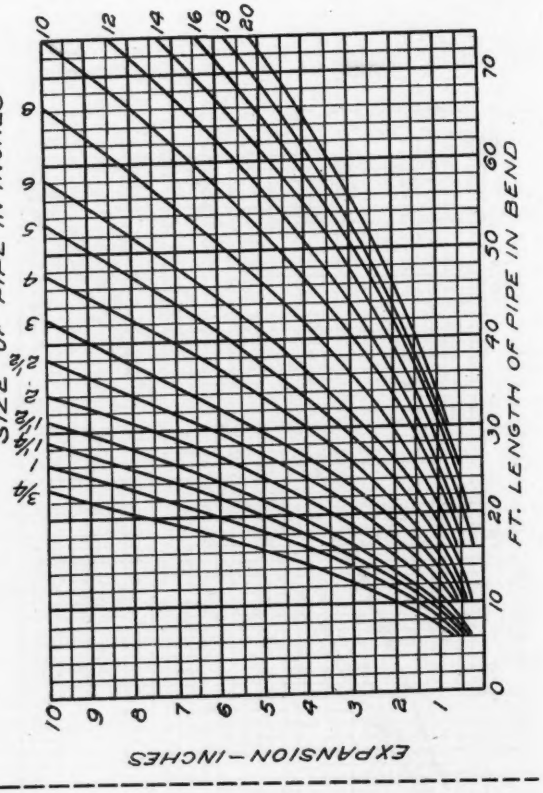
| | Rating | | |

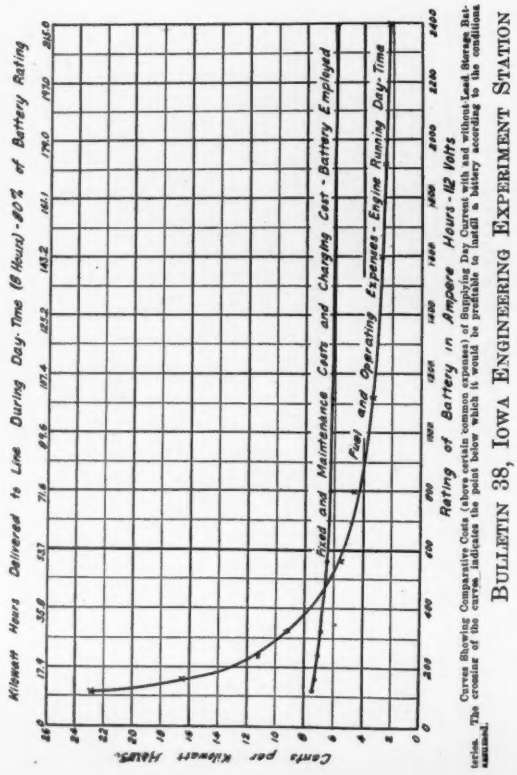
VARIATION IN CAPACITY OF A REFRIGERATION MACHINE



LINE MARKED "capacity of machine" shows diminished capacity as the back pressure is reduced. Curve "cost of fuel" shows ratio of increase in cost of fuel per ton of refrigeration with decrease in back pressure. The "Work Required" curve gives the relative amount of work required per unit of refrigeration at various back pressures. (De La Vergne Co.)

EXPANSION CARED FOR BY LENGTHS OF PIPE, 12,000 LB. FIBER STRESS

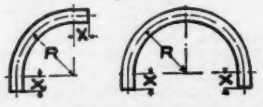



Kilowatt Hours Delivered to Line During Day-Time (8 Hour) - 80% of Battery Rating
Fixed and Maintenance Costs and Charging Cost - Battery Employed
Fuel and Operating Expenses - Engine Running Day-Time
Rating of Battery in Ampere Hours - 12 Volts
Cents per Kilowatt Hours.

Curves Showing Comparative Costs (abscissas nominal) of Supplying Day Current and without Lead Storage Batteries. The crossing of the curves indicates the point below which it would be profitable to install a battery according to the conditions assumed.

BULLETIN 38, IOWA ENGINEERING EXPERIMENT STATION

RADIUS AND STRAIGHT ENDS FOR PIPE BENDS



Size	Advisable Radius		Minimum Radius	
	R	X	R	X
1	5″	2¼″	2¾″	2¼″
1¼	6¼″	2½″	3″	2½″
1½	7½″	2¾″	3¾″	2¾″
2	10″	3″	5″	3″
2½	1′ 1″	3½″	7″	3½″
3	1′ 2″	4″	8″	4″
3½	1′ 5″	4½″	10″	4½″
4	1′ 7″	5″	1′ 0″	5″
4½	1′ 10″	5½″	1′ 2″	5½″
5	1′ 11″	6″	1′ 3″	6″
6	2′ 6″	6½″	1′ 8″	6½″
7	2′ 10″	7″	2′ 0″	7″
8	3′ 4″	8″	2′ 4″	8″
9	3′ 11″	10″	2′ 11″	10″
10	4′ 6″	1′ 0″	3′ 4″	1′ 0″
12	5′ 4″	1′ 2″	4′ 2″	1′ 2″
14	6′ 9″	1′ 4″	5′ 5″	1′ 4″
15	7′ 2″	1′ 6″	5′ 10″	1′ 6″
16	8′ 0″	1′ 8″	6′ 6″	1′ 8″
18	8′ 10″	2′ 0″	7′ 4″	2′ 0″
20	10′ 0″	2′ 0″	8′ 4″	2′ 0″
22	10′ 10″	2′ 0″	9′ 2″	2′ 0″
24	11′ 10″	2′ 0″	10′ 0″	2′ 0″
26	13′ 10″	2′ 6″	12′ 0″	2′ 6″
28	18′ 0″	2′ 6″	16′ 0″	2′ 6″
30	20′ 0″	2′ 6″	18′ 0″	2′ 6″

The radii and lengths of straight pipe required on each end of a bend here given can be applied to any type of bend.

Where the length of curved portion of a bend (taken on center line) plus 2X is greater than the average length of a random length of pipe, the bend must be made in two or more pieces, and the bend designed accordingly.

BEST MFG. CO.

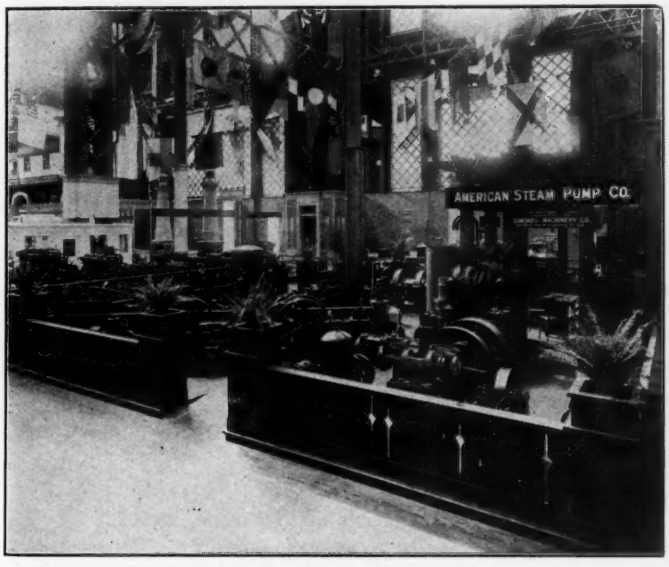
bureau decided to make tests to establish a list of permissible explosion-proof motors, and issued its Schedule 2, "Fees for Testing Explosion-Proof Motors." This schedule gave the general conditions under which motors could be submitted for test and the fees to be charged for making such tests. Technical Paper 101 sets forth more fully than Schedule 2, the details that the bureau considers essential to satisfactory explosion-proof motor construction.

The Bureau of Mines considers a motor to be permissible when it is the same in all respects as the sample motor that passed certain tests made by the bureau and when it is installed and used in accordance with the conditions prescribed by the bureau.

The paper gives the requirements for approval of motors; outlines the nature of the approval of the bureau and describes the approval of an explosion-proof coal-cutting equipment.

Trade Notes

AMONG the interesting exhibits at the Panama-Pacific Exposition is that of the American Steam Pump Co., located at Avenue E and Second St., in the Palace of Machinery, and consisting of a most comprehensive showing of the various types of Marsh and American pumps and air compressors manufactured by this company.

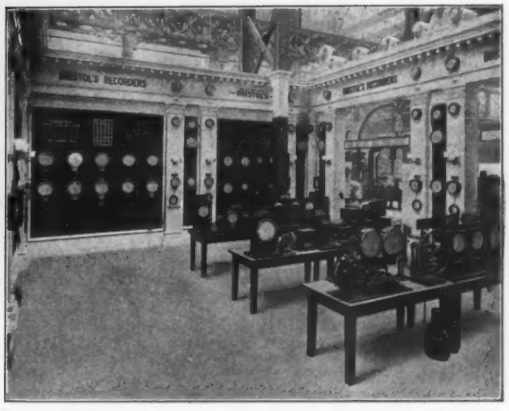


Among other interesting features, there is shown a sectional model of one of their Marsh Simplex boiler feed pumps, giving a view of all the internal parts in order to demonstrate the simplicity of construction. In this type of pump there are only 2 moving parts on the steam end and no outside valve motion. The manufacturers claim to have some 125,000 Marsh pumps in actual operation throughout the country. Next is a Marsh Deep Well engine with displacement plunger with a bronze artesian water cylinder. This type of equipment is used for raising water from very deep wells and forcing it into an overhead tank with one operation.

Added to the above is a showing of American steam pumps for various duties, several exhibits of American Motor Driven power pumps with capacities ranging from 6 to 1500 gal. per min., and 3 of the American Improved Belt Driven air compressors, designed according to the latest engineering practice and claimed to be very efficient in operation. They are built with capacities ranging from 3 to 850 cu. ft. of free air per minute, in both single and duplex types.

Several of the pumps shown in actual operation, add to the interest of the exhibit, which is in charge of the Simonds Machinery Co., 117-121 New Montgomery St., San Francisco, Calif., representing the manufacturers, the American Steam Pump Co., of Battle Creek, Mich.

ONE OF THE ATTRACTIVE mechanical exhibits at the Panama-Pacific International Exposition, at San Francisco, is that of the Bristol Co., Waterbury, Conn., which includes their extensive lines of recording instruments for pressure, vacuum, liquid level, differential pressure, temperature, electricity, time, motion, speed, humidity, etc. This exhibit is located in the Palace of Machinery in section 32, and occupies a floor space 40



ft. long and 30 ft. wide. The decorations of the superstructure of the booth are actual models of Bristol recording instruments.

On the lower part of the outside columns of the booth, actual working models of Bristol instruments are to be exhibited in operation, producing records of atmospheric temperature, the level of the tide in the bay, over a distance of several hundred feet, electrically,

also records of conditions on the electrical circuits of the Palace of Machinery including volts, and cycles, or frequency, record of the water pressure in the mains of the Palace of Machinery, and records of the operation of a series of signal switches provided for the visitor to manipulate at will.

Inside the booth, one view of which is shown herewith, more than 100 complete working models of the Bristol recording instruments are mounted on walls and tables, and of these instruments quite a number are arranged in the form of demonstration outfits which can be operated by hand by the visitor.

For instance, a hand-operated generator is provided for lighting a series of lamps and mounted with it is a Bristol recording voltmeter, an ammeter and a wattmeter recording simultaneously the voltage, amperage and wattage on these lamp circuits.

Another interesting demonstration outfit is a pair of the new Bristol patent long distance electric thermometers by means of which the visitor is shown how the temperature of his own hand could be indicated automatically on an instrument 50 mi. away from the point at which the temperature is measured.

The instruments in many demonstration outfits are shown with glass fronts, or without covers, making it possible for the visitor to see the simple internal construction, and to study the principles of operation, and this makes the exhibit one of great educational value.

Other Bristol products such as Bristol patent steel belt fasteners and Bristo patent safety set screws are also exhibited.

A booklet reproducing photographs of the complete booth, and each of the different sections of the exhibit with illustrations and explanations of each of the principal demonstration models will be mailed to those interested, upon request.

AS A RESULT of a 6 months' trial of 2 2½-in. Simplex "Seatless" blowoff valves, shipped on Feb. 11, 1914, by Yarnall-Waring Co., the Berwind-White Coal Mining Co., Windber, Pa., has since re-ordered as follows: 1 2½-in. valve; 4 2½-in. valves; 3 2½-in. valves; 8 2½-in. valves; 26 2½-in. valves; 37 of these valves were ordered in the month of May. A recent order is also announced for 56 2½-in. steel Simplex "Seatless" blowoff valves for the Corrigan-McKinney Co., Cleveland, O.

THE "S-C" REGULATOR CO., Fostoria, Ohio, announces that it will be represented in the following cities and the parties referred to will be in charge of these branch offices: Chicago, L. K. Dickerson and E. H. Bolton, 1535 Lytton Bldg.; New Orleans, Geo. Keller, 315 Carondelet St.; Birmingham, McClary-Jemison Mchy. Co.; Atlanta, E. F. Scott, M. E., 702 Candler Bldg.; Charlotte, N. C., James E. Weinhold, 1213 Realty Bldg.

THE NORDBERG MFG. CO., of Milwaukee, Wis., announces that E. W. Swartwout, formerly of the Chicago office, will be associated, after June 1, with Mr. MacLaren, in the New York office of the company. Enlarged offices have recently been taken in the new Equitable Bldg. (120 Broadway), New York. The Chicago office will be in charge of John E. Lord.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

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About nine words make a line. Minimum space sold, two lines.

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Circulation of this issue, 22,500.

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537 S. Dearborn Street
Chicago

Position Wanted

POSITION WANTED—As assistant engineer, experienced; I. C. S. student; best references; strictly sober, hold first class license; will consider small salary if advanced as merited. Address Robert Pieper, Bloomington Prairie, Minn. 5-1-3

POSITION WANTED—By young man, age 21 as oiler or helper in power plant. A. S. C. graduate, electrical course. Some experience small gas engines. Would work a while for experience. Address O. W. House, Rush Springs, Okla. 6-15-1

POSITION WANTED—By engineer in medium sized power plant or helper in large one. Have third class Ohio License. 5 years' experience with steam engine and boilers. Some experience with electricity. Good habits. Sober. 25 years old. Good reference. Address Emmett R. Ralston, Box 43, Cheshire, Ohio. 6-15-1

POSITION WANTED—As chief engineer in a small or medium sized plant. Twelve years' practical and technical experience in operation and maintenance of steam, electric refrigerating, pumping and condensing equipment. First class license. Married; age 30. Employed. Address Practical Engineer, Box 392, Chicago, Ill.

POSITION WANTED—Man 39 years old, long experience with electric light and water works plants. Five years manager on plant. Strictly sober. Best references. Wants position as manager plant. Texas or Oklahoma preferred. Address C. X., 809 Austin Ave., Brownwood, Texas. 6-1-2

POSITION WANTED—By engineer in medium sized power plant, or large coal mine. Have Illinois license; 7 years' experience with steam engines and boilers. Some experience with electricity. Good habits. References. 24. Illinois preferred. Address W. E. Rohline, Box 224, Farmington, Ill. 6-1-2

POSTION WANTED—Steam engineer wants position in water works or mill plant 33 yr. old. Married. Sober. Best of references. Iowa preferred. Address F. J. Kirkpatrick, Indianola, Iowa. 6-1-2

POSITION WANTED—By engineer, 8 yr. experience with steam and electric. Understand gas engines and refrigeration. Temperate, reliable, married man. Member N. A. S. E. Address W. H. Snyder, 53 Brown St., Hartford, Conn. 6-15-1

POSITION WANTED—By engineer with years of experience in ice and electric light plants. Understand both a.c. and d.c. machines. Am a graduate of one of the best colleges in Middle West. A1 references. Ezra D. Dumas, Clarinda, Iowa. 6-1-2

POSITION WANTED—By young man with 10 years' practical experience from boiler room up. Hold first class Massachusetts engineer's license. Will go anywhere. Am total abstainer and can furnish A1 references. Address Practical Engineer, Box 393, Chicago, Ill. 6-1-2

POSITION WANTED—By licensed engineer, age 30. Good mechanic. 10 yr. experience. Can furnish A No. 1 references. Chicago preferred. Address Box 390, Practical Engineer, Chicago, Ill. 6-1-2

POSITION WANTED—As assistant in power house. I. C. S. student. References. Sober. Will consider small salary if advanced as to merits. Address Fred Lamb, Box 15, Longmont, Colo. 6-15-1

Wanted

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Calif.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Calif.; Washington, D. C. This is an excellent chance for a hustler, who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

FREE ENGINEERING BOOKS and power plant tools and specialties for securing new subscribers to Practical Engineer. A dandy chance for the engineer with a little spare time to get some fine premiums. Send for free descriptive circular and terms. Address Practical Engineer, Subscription Department, Chicago, Ill.

WANTED—Representative to cover territory more thoroughly. Boiler room necessities. Liberal commissions. Old established house. Apply by letter. H. F. Maurel, 534 W. 22nd St., New York City. 4-1-6

WANTED—Stationary engineers to handle pump counter; nothing like it on the market; large commission. Address Box 396, Practical Engineer, Chicago, Ill. 6-1-2

Help Wanted

WANTED—Agents on commission to sell our Shaking Grates. We will install grates on trial or put in on test at our expense with any grate made. Address Armstrong Mfg. Company, Springfield, Ohio. tf.

WANTED—Agents handling engine and boiler-room specialties in every section for side line paying large commissions. Give experience, line carried, and territory covered. Address Practical Engineer, Box 381, Chicago, Ill. tf.

WANTED—Agents to introduce the greatest power saver of the day; liberal commission. Send today for sample and directions. Address Cardinal Mfg. Co., Cleveland, Ohio. 6-15-1

For Sale

FANS AND MOTORS—For sale a large number of A.C. and D.C. electric fans, new and at prices from $6.00 each upwards. All styles, including oscillating, ceiling, desk, etc. Motors alternating 1/12 to 7½ H.P., one, two and three phase. Motors, direct current 1/40 to 30 H.P. for all voltages. Generators also. Fidelity Electric Co., Lancaster, Pa. 4-1-4

TWO 50 K.W. General electric 230-volt dir. con. Harrisburg engines, $800; 125 K.W. Crocker Wheeler 125-volt dir. con. Allis Corliss cross compound engine, $1250; 70 H.P. DeLaVergne twin cylinder oil engine, $1400; 100 K.W. General Electric 125-volt dir. con. Erie automatic engine, $750. Duzets & Son, 50 Church St., New York, N. Y. tf.

Patents and Patent Attorneys

PATENTS—C. L. Parker Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Bldg. Washington, D. C. tf.

PATENTS THAT PROTECT AND PAY—Advice and books free. Highest references. Best results. Promptness assured. Send sketch or model for search. Watson E. Coleman, Patent Lawyer, 624 F St., Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact costs. Send for full information. tf.

PATENTS—Send sketch for free search and reports. Books on patents and book of reference letters sent free. John S. Duffie & Co., 612 F St., Washington, D. C. tf.

A. P. CONNOR, consulting electrical and mechanical engineer, attorney-at-law and solicitor of patents and trade-marks, 121 Carroll St., S. E., Washington, D. C. tf.-x.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Educational and Instruction

ENGINEERS' POCKET MANUAL, 175 pages, edited by University of Tennessee, will be mailed every subscriber sending in NEW subscriptions (not your own) to Practical Engineer. Gilt edges; bound in leather.

Miscellaneous

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill. tf.

Sparks From The Advertising Pages

We have said before in these columns that "deception in advertising cannot permanently endure." The unscrupulous advertiser who deceives the unsuspecting public by misleading statements in his advertising will soon be a relic of the past.

A change in the principles of advertising—a change in the principles of advertisers—have wrought a corresponding change for the better, in advertising.

Incidentally, new laws are enforcing truthfulness in advertising.

The State of New York has recently passed an act known as the Mill's Bill. It reads in effect, as follows:

"*Untrue and misleading advertisements:*—If any person, firm, corporation or association, or agent or employee thereof, with intent to sell or in any way dispose of merchandise, real estate, service, or anything offered by such person, firm, corporation or association or agent or employee thereof, directly or indirectly, to the public for sale or distribution, or with intent to increase the consumption thereof, or to induce the public in any manner to enter into any obligation relating thereto, or to acquire title thereto, or an interest therein, knowingly makes, publishes, disseminates, circulates, or places before the public, or causes, directly or indirectly, to be made, published, disseminated, circulated, or placed before the public, in this state, in a newspaper, magazine or other publication, or in the form of a book, notice, circular, pamphlet, letter, handbill, poster, bill, sign, placard, card, label or tag, or in any other way, an advertisement, announcement or statement of any sort regarding merchandise, service or anything so offered to the public which contains any assertion, representation or statement of fact that is untrue, deceptive or misleading, or that amounts to an offer to sell, barter or exchange real estate by means of prizes, rewards, distinctions, or puzzle methods, such person, corporation or association, or the members of such firm, or the agent of such person, corporation, association or firm, shall be guilty of a misdemeanor, punishable by a fine of not less than twenty-five dollars nor more than one thousand dollars, or by imprisonment for not more than one year, or by both such fine and imprisonment."

These changes and laws are not of destructive nature, but are primarily constructive forces. They do not destroy advertisers who have been dishonest, but simply reveal to them the weakness of their position.

Practical Engineer has always maintained a rock-ribbed principle of refusing all fraudulent advertising.

For the sake of its readers who, as buyers, must be protected—for the sake of its advertisers, who desire to appear in good company, Practical Engineer has applied this principle without a single exception. You are absolutely safe in using its pages as guidance in the selec of your equipment and supplies.

Each advertiser in Practical Engineer makes only one kind of appeal—the appeal to reason. He does not coerce the engineer into buying; the spirit of the advertiser—the tone of his advertisement conveys the simple entreaty, "Come, let us reason."

When every trade journal, newspaper, magazine, and the like, have adopted this principle of excluding dishonest advertising, then will we see the fulfillment of the modern buyer's dream of Utopia.